

# PROJECT MANUAL

## Middle School Additions Hallsville R-IV School District Hallsville, Missouri

**ISSUED FOR BIDDING**

**A/E Project No. 21-5052**

**Klingner & Associates, P.C.  
907 East Ash Street  
Columbia, MO 65201  
(573) 355-5988**

**Date of Issue:**

**January 2023**



**SECTION 000103**  
**PROJECT DIRECTORY**

**OWNER:** **HALLSVILLE R-IV SCHOOL DISTRICT**  
421 East Highway 124  
Hallsville, MO 65255  
John Downs, Superintendent  
(573) 696-5512

**PROJECT MANAGER / ENGINEER:** **KLINGNER & ASSOCIATES, P.C.**  
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Columbia, MO 65201  
John Neyens, PE, Project Manager  
(573) 355-5988

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D. Cullan Duke, LA  
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**FIRE SUPPRESSION ENGINEER:** **KLINGNER & ASSOCIATES, P.C.**  
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Josiah Moore, PE  
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**PLUMBING ENGINEER:** **KLINGNER & ASSOCIATES, P.C.**  
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Matthew Bridges, PE  
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**ELECTRICAL ENGINEER:**

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Columbia, MO 65201  
Josiah Moore, PE  
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**STRUCTURAL ENGINEER:**

**KLINGNER & ASSOCIATES, P.C.**  
616 N. 24<sup>th</sup> Street  
Quincy, IL 62301  
Nathan Marold, PE  
(217) 223-3670

**CONSTRUCTION MANAGER:**

**S. M. WILSON & CO.**  
2185 Hampton Ave.  
St. Louis, MO 63139  
Patrick Aylesworth, Project Manager  
314-633-9689

END OF SECTION 000103

SECTION 000107  
SEALS PAGE

1.1 DESIGN PROFESSIONALS OF RECORD

A. Project Engineer :

1. **John J. Neyens**
2. 2012009233.
3. Responsible for Division 00 and 02



B. Architect:

1. **H. Michael Carter**
2. A-6846.  
Responsible for Divisions 04, 06, 07, 08, 09, 10, 11, and 12



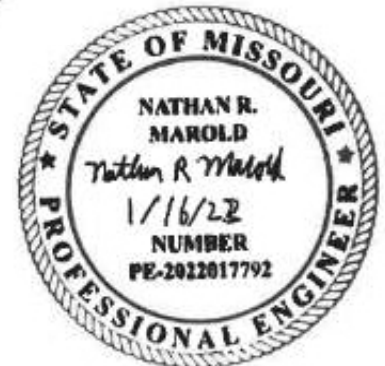
C. Civil Engineer:

1. **Curt S. Wavering**
2. 2011009046.  
Responsible for Divisions 31, 32, and 33



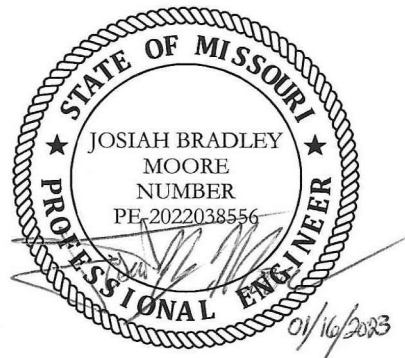
D. Structural Engineer:

1. **Nathan R. Marold**
2. 2022017792.  
Responsible for Divisions 03 and 05



E. Fire Protection:

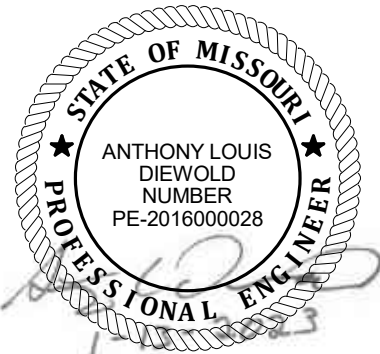
1. **Josiah B. Moore**
2. 2022038556.
3. Responsible for Division 21





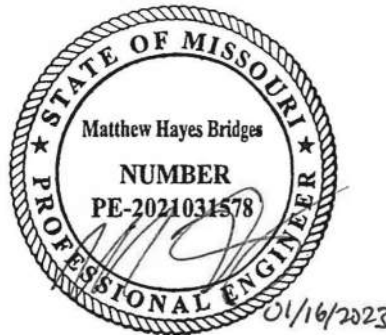
F. Plumbing:

1. **Anthony L. Diewold**
2. 2016000028.
3. Responsible for Division 22



G. Mechanical:

1. **Matthew H. Bridges**
2. 2021031578.
3. Responsible for Division 23



H. Electrical:

1. **Josiah B. Moore**
2. 2022038556.
3. Responsible for Division 26, 27, and 28

END OF SECTION 000107

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*Hallsville R-IV School District  
Middle School Additions  
421 East Highway 124, Hallsville, MO 65255*

*Project No. 21-5052  
January 2023*

|        |                               |
|--------|-------------------------------|
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END OF SECTION 000110

## SECTION 024120 SUBSURFACE CONDITIONS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This section describes soils investigation at the site and use of data resulting from that investigation.

#### 1.2 SOILS INVESTIGATION REPORT

- A. General:

- 1. A soils investigation report has been prepared for the site by the soil investigation engineer/architect selected by the Owner.

- B. Use of Data:

- 1. Information on the nature of the soil conditions previously encountered at the site, which may be shown on the drawings or contained in the *Soils Report*, has been provided for bidder's information and shall not be construed as a guarantee of the subsurface conditions.
  - 2. The Contractor should visit the site and shall be responsible for determining to his/her satisfaction, prior to bidding, the actual site conditions.
  - 3. A copy of the Geotechnical Investigation, *Middle School Classroom, Athletic Track/Field and Improvements – Hallsville, Missouri (9/8/2022)*, performed by Geotechnics Soil & Material Testing, a Division of Klingner & Associates, P.C., is attached at the end of the specifications, solely for the Contractor's information.

#### 1.3 QUALITY ASSURANCE

- A. Readjust work performed that does not meet technical or design requirements, but make no deviation from the Contract Documents without specific and written approval from the Owner.

#### 1.4 UNDERGROUND UTILITIES

- A. The drawings indicate the best knowledge of the Owner and Engineer/Architect on the general location and nature of the existing and/or proposed underground utilities in the area of construction. Exploratory excavations at the site to determine insitu locations were not conducted.
- B. The Contractor shall be responsible for locating all utilities on site prior to the start of construction. The Contractor shall contact Missouri One Call at 1-800-344-7483, 48 hours before scheduled work.
- C. Damages to utilities caused by the Contractor's failure to properly investigate existence in the area shall be the sole responsibility of the Contractor.

END OF SECTION 024120

## MIDDLE SCHOOL CLASSROOM, ATHLETIC TRACK/FIELD AND IMPROVEMENTS

Hwy 124

Hallsville, MO 65255

September 8<sup>th</sup>, 2022

*Prepared for:*

### HALLSVILLE R-IV SCHOOL DISTRICT

521 East Highway 124

Hallsville, MO 65255

*Prepared by:*

### GEOTECHNICS, A DIVISION OF KLINGNER & ASSOCIATES, P.C.

4510 Paris Gravel Road

Hannibal, MO 63401

Project No. 21-5052

September 8, 2022

Hallsville R-IV School District  
Attn: Mr. John Downs  
421 East Highway 124  
Hallsville, MO 65255

RE: Geotechnical Investigation: Middle School Classroom,  
Athletic Track/Field and Improvements - Hallsville, Missouri

Dear Mr. Downs:

In accordance with your request, our firm has conducted the geotechnical investigation for the proposed New Middle School Classroom, Athletic Track/Field and Improvements at the existing Hallsville School campus in Hallsville, Missouri. The geotechnical exploration and report has been conducted in general accordance with the agreement dated May 18<sup>th</sup>, 2022. The report presents the investigation findings and provides recommendations for foundation, slabs on grade, backfill, subgrade, pavement subgrade, soil parameter estimates, seismicity, and related site earthwork recommendations.

We appreciate the opportunity to provide geotechnical services for your project. As always, if you have any questions please do not hesitate to contact us.

Sincerely,

GEOTECHNICS, A DIVISION OF KLINGNER



Brian Joseph Sick, P.E.  
Geotechnical Department Services Manager  
Missouri P.E. No. 2005022155





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Appendix G Boring Logs-Athletic Track/field and Improvements

## **1.0 SCOPE OF SERVICES**

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The scope of our services for this project consisted of investigating the site's subsurface conditions by drilling a total of thirty (30) test borings near the perimeter of the new construction areas of the separate additions and improvements for the Hallsville New Middle School Classroom, Athletic Track/Field and Improvements in Hallsville, MO. Nine (9) borings were scheduled to be drilled in the middle school classroom addition, and twenty-one (21) borings were performed for the athletic track/field and site improvements. The test borings were drilled to depths of 6½ to 26½ feet (elev. 866.6 to 883.4) below the existing ground surface.

The locations and ground surface elevations at the boring locations were staked and graded in the field by our drill crew and are indicated on the enclosed test boring location sketch and test boring logs. The elevations for the Middle School addition were determined by referencing the finish floor elevation at the south entry doors of the building wing just north of the new building addition at the reported elevation of 899.92, while the elevations for the track and field improvements was determined by referencing the top of flange bolt south of boring 15 (BM#1) with reported elevation of 890.16. The scope of services also consisted of a laboratory testing program and an engineering analysis of the soil-structure interaction with subsequent foundation, slabs on grade, subgrade, pavement subgrade, soil parameter estimate recommendations, seismicity, and backfill and related site earthwork recommendations.

## **2.0 SITE DESCRIPTION**

---

The proposed project site is at the existing school building track and field located at 6401 East Hwy 124 and at the Middle School at 421 East Hwy 124. The sites are north of Hwy 124 and south of North Street. The site is covered in track and field, grass lawn, concrete sidewalk, playground, pavement and gravel sections of the existing school facilities. The site is relatively flat to gently sloping and generally drains away from the existing structures toward the existing drainage structures/features and generally to the south toward Hwy 124. The ground surface elevations at the borings ranged from 883.3 to 899.1. The topsoil and recent fill section summary at the individual boring locations follows below:

Table 1: Topsoil and Recent Fill Thickness Summary

| Boring | Topsoil/Aggregate Thickness | Estimated Recent Fill Thickness, ft. (bot. elev.) |
|--------|-----------------------------|---------------------------------------------------|
| 1      | ±5" Topsoil                 | ± 7½/891½                                         |
| 2      | ±3" Topsoil                 | ± 6/892½                                          |
| 3      | ±6" Topsoil                 | ± 5/894                                           |
| 4      | ±5" Topsoil                 | ± 2½/896                                          |
| 5      | ±5" Topsoil                 | ± 5/893                                           |
| 6      | ±6" Topsoil                 | n/a                                               |
| 7      | ±4" Aggregate               | n/a                                               |
| 8      | ±8" Aggregate               | n/a                                               |
| 9      | ±7" Aggregate               | n/a                                               |
| 10     | ±5" Topsoil                 | n/a                                               |
| 11     | ±2" Topsoil                 | n/a                                               |
| 12     | ±7" Topsoil                 | n/a                                               |
| 13     | ±8" Aggregate               | n/a                                               |
| 14     | ±6" Topsoil                 | n/a                                               |
| 15     | ±7" Aggregate               | n/a                                               |
| 16     | ±8" Aggregate               | ± 7½/882                                          |
| 17     | ±7" Topsoil                 | n/a                                               |
| 18     | ±7" Topsoil                 | ± 7½/878 (Possible Fill)                          |
| 19     | ±7" Topsoil                 | ± 5/883 (Possible Fill below 2½)                  |
| 20     | ±3" Topsoil                 | n/a                                               |
| 21     | ±7" Topsoil                 | ± 5/878½ (Possible Fill below 2½)                 |
| 22     | ±7" Topsoil                 | n/a                                               |
| 23     | ±7" Topsoil                 | n/a                                               |
| 24     | ±6" Topsoil                 | n/a                                               |
| 25     | ±4" Topsoil                 | n/a                                               |
| 26     | ±4" Topsoil                 | n/a                                               |
| 27     | ±4" Topsoil                 | n/a                                               |
| 28     | ±6" Topsoil                 | ± 5/894                                           |
| 29     | ±6" Topsoil                 | ± 4/895                                           |
| 30     | ±6" Topsoil                 | n/a                                               |

### 3.0 SITE GEOLOGY

In the vicinity of the proposed project site the terrain is underlain by recent fill and natural soil deposits of glacial origin. Although it did not appear that the boring locations encountered loessial soils, this area may have loessial soils present in isolated areas of the site. The loessial soils, if encountered, were deposited by the prevailing winds and, in general, consist of an upper mantle of fat clay that is underlain by a thin seam of lean clay.

The glacial soils were deposited by melting ice and flowing melt water as ice-marginal sediment from glacial events from the Pre-Illinoian Age glaciers. The glacial soils predominantly consist of fine-grained soils that many times are interspersed with coarse grained soils in isolated seams and pockets. This region of Missouri is found in the Smooth Plains Sub-Section in the Dissected Till Plains Section of the Central Lowland Province of the Interior Plains Physiographic Division. The area in general is characterized by gently to moderately rolling, grass and tree covered plains with areas of heavy timber found alongside the creeks and rivers in this area. The drainage features in this area around Hallsville, MO are dendritic in structure and is part of the Missouri River Drainage Basin; regionally the area flows to the south toward the Missouri River. The topography and drainage can trace its origin back to the glaciation events of the Pre-Illinoian stage. Generally, in this area of Boone County, Pennsylvanian Age bedrock will be found at depths greater than 40 feet.

## **4.0 PROPOSED DEVELOPMENT**

---

We understand that the project scope for the Hallsville R-IV School District Capital Improvement Program is to include a Middle School Classroom addition consisting of an approximate 15,000 SF single-story addition with 8 classrooms and support spaces. The classroom will be constructed of severe weather resistant construction, provide connectivity between the current middle school and intermediate school and have the capability to support a future second level addition. We presume grade will be similar to the existing slab elevations ( $\pm 900$ ); therefore grade changes should be less than 2 feet. Foundation reactions and construction plans have not been provided to us for our review. We have presumed the classroom addition will utilize a combination of bearing walls and isolated column footings for support. We have presumed relatively light foundation loads for the addition, with our geotechnical engineering analyses considering maximum bearing wall loads of up to 5 kips per foot and maximum isolated column loads of up to 60 kips.

The Athletic Track/Field and Improvements will be constructed in the vicinity of the existing football field. The existing locker room will be demolished, the field will be adjusted, field lighting will be relocated and a revised drive for the bus barn will be provided. The improvements will consist of new artificial turf, visitor's bleachers, new locker room, stadium parking and concourse, and relocate home bleachers and press box. We have presumed foundation loads will be light and that the grade changes will be minor for the improvements, considering structural fills and excavations approximately 3 feet or less. If our understanding of the new construction addition or any of our estimates and/or presumptions do not accurately represent this project, we should be notified to provide a revision to this report.

## 5.0 SUBSURFACE CONDITIONS

The results of the geotechnical investigation indicated that the proposed Hallsville New Middle School Classroom, Athletic Track/Field and Improvements site was covered by a thin veneer of topsoil/aggregate and recent fill (classroom addition) over natural soil deposits of Pre-Illinoian Age glacial soils. Topsoil and aggregate thickness at the borings ranged from approximately 2 to 8 inches. We interpreted that the recent fill was encountered in all of the classroom addition borings except boring 6 and 30 to depths of approximately 2½ to 7½ feet (elev. ±891½ to 896). For the Track/Field area, we interpreted that the recent fill or potential recent fill was encountered in borings 16, 18, 19, and 21 to depths of approximately 2½ to 7½ feet (elev. ±878 to 883); discernment of fill soils of like composition to the natural soil profile can be difficult. The fill soils consisted of lean clay (CL), fat clay (CH), and lime fines (SM), with varying amounts of sand, gravel and construction debris in the classroom area. The fill soils were soft to hard in consistency and medium dense in apparent relative density with N values ranging from 2 to 22 blows per foot and 50 blows for half an inch in boring 29 in concrete debris. Please see the individual boring logs in the appendix for detailed information.

Below the topsoil/aggregate veneer and recent fill, glacial soils were encountered to the boring completion depths. The glacial soil was composed of fine-grained soils and consisted of oxidized yellow brown, brown, gray and light gray mottled fat clay sand (CH) and lean clay with sand (CL). These soils were medium to very stiff in consistency with N values ranging from 4 to 17 blows per foot and unconfined compressive strength values varying from 0.72 to 2.81 T.S.F. Portions of the till were composed of lean clays and high plasticity fat clays with liquid limit values on select samples ranging from 43% to 89% and plasticity indices ranging from 24% to 56% as indicated by Atterberg Limits testing performed in the top 5 feet in depth. A bulk sample was collected from the athletic field in borings 24 to 27 for laboratory testing of the soil. The bulk sample was then processed and mixed/combined to represent a cross section of the soil types present in the athletic field to a depth of approximately 4 to 5 feet. Results of the testing of the athletic field soils indicated a maximum dry density of 102.1 P.C.F. at an optimum moisture content of 20.4% with an Atterberg Limit determination on the bulk sample indicating a liquid limit of 55% with a plasticity index of 34% with an as-received moisture content of 17.7%. A table of laboratory data from the bulk sample follows:

Table 2: Bulk Sample Value Summary

| Boring No. | Maximum Density / Optimum Moisture PCF/% | Moisture Content % | Atterberg % (LL/PL) | %<#200 |
|------------|------------------------------------------|--------------------|---------------------|--------|
| 24 to 27   | 102.1 / 20.4                             | 17.7               | 55/34               | 91.3   |

Previous studies near the site and published geologic information suggest that the glacial soil generally increases in strength with depth and extends to Pennsylvanian Age bedrock at depths typically below 40 feet. The till extended to the boring's completion depths of 6½ to 26½ feet (elev. 866.6 to 883.4) below the existing ground surface.

## 6.0 GROUNDWATER OBSERVATIONS

Observations to determine the apparent presence of groundwater were conducted during drilling, at completion and up to 24 hours after completion of the test borings. The groundwater levels at the borings were as follows:

Table 3: Groundwater Depth Observations Summary

| Boring No. | Groundwater Depth/Elev.<br>During Drilling | Groundwater Depth/Elev.<br>@ Completion | Groundwater Depth/Elev.<br>@ Hours After Completion |
|------------|--------------------------------------------|-----------------------------------------|-----------------------------------------------------|
| 1          | Dry                                        | Dry                                     | Dry @ 24 Hrs.                                       |
| 2          | Dry                                        | Dry                                     | Dry @ 24 Hrs.                                       |
| 3          | Dry                                        | Dry                                     | n/a                                                 |
| 4          | Dry                                        | Dry                                     | Dry @ 3¼ Hrs.                                       |
| 5          | Dry                                        | Dry                                     | Dry @ 2¼ Hrs.                                       |
| 6          | Dry                                        | Dry                                     | n/a                                                 |
| 7          | Dry                                        | Dry                                     | n/a                                                 |
| 8          | Dry                                        | Dry                                     | n/a                                                 |
| 9          | Dry                                        | Dry                                     | n/a                                                 |
| 10         | Dry                                        | Dry                                     | n/a                                                 |
| 11         | Dry                                        | Dry                                     | n/a                                                 |
| 12         | Dry                                        | Dry                                     | n/a                                                 |
| 13         | Dry                                        | Dry                                     | n/a                                                 |
| 14         | Dry                                        | Dry                                     | n/a                                                 |
| 15         | Dry                                        | Dry                                     | n/a                                                 |
| 16         | Dry                                        | Dry                                     | n/a                                                 |
| 17         | Dry                                        | Dry                                     | Dry @ 6 Hrs.                                        |
| 18         | Dry                                        | Dry                                     | Dry @ 6½ Hrs.                                       |
| 19         | Dry                                        | Dry                                     | n/a                                                 |
| 20         | Dry                                        | Dry                                     | n/a                                                 |
| 21         | Dry                                        | Dry                                     | n/a                                                 |
| 22         | Dry                                        | Dry                                     | n/a                                                 |
| 23         | Dry                                        | Dry                                     | n/a                                                 |
| 24         | Dry                                        | Dry                                     | n/a                                                 |
| 25         | Dry                                        | Dry                                     | n/a                                                 |
| 26         | ±7/882                                     | ±8/881                                  | n/a                                                 |
| 27         | ±4/885                                     | Dry                                     | n/a                                                 |
| 28         | Dry                                        | Dry                                     | Dry @ 1½ Hrs.                                       |
| 29         | Dry                                        | Dry                                     | Dry @ 1 Hr.                                         |
| 30         | Dry                                        | Dry                                     | Dry @ ½ Hr.                                         |



These findings indicate that static water level and/or perched groundwater is anticipated to be below the expected depth of excavation. Due to the composition of the soils at the site and the poor surface drainage, it is expected that perched or trapped groundwater can be found at depths above these measurements, especially during seasonally wet periods. In view of the low permeability of the soils at the site, dewatering of perched groundwater and/or trapped surface water from shallow, temporary excavations can typically be accomplished by pumping from sump pits.

## **7.0 GEOTECHNICAL ENGINEERING ANALYSES AND FOUNDATION RECOMMENDATIONS**

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The results of the geotechnical investigation indicate that the proposed Hallsville New Middle School Classroom, Athletic Track/Field and Improvements, proportioned as presumed, may be supported by shallow reinforced concrete footings based in the natural soils or new structural fill or backfill, provided that the following recommendations are implemented. Total settlements of foundations proportioned as recommended should be less than approximately 1" while differential settlements between adjacent foundation elements should be less than about  $\frac{3}{4}$ ". Exterior footings and footings in unheated areas should be based at least 36 inches beneath the finished exterior grade for frost protection.

Unsuitable (soft or unstable) soils, if encountered, should be removed from the footing excavations, and consequently the footing extended the additional depth or replaced with suitable material as recommended below. For spread footings the depth of overexcavation should be at least 3 feet or to suitable soil whichever is shallower and at least 50% wider than the design width for lateral stress dissipation. For bearing wall footings, the over-excavations, if needed, should extend to at least 2 feet (or to adequate bearing material, whichever is shallower) and should be at least 50% wider than the design width for lateral stress dissipation. Once the limit of the overexcavation is reached, the exposed surface should be compacted with suitable compaction equipment prior to backfilling. Replacement material (if required) for unsuitable soils in the footings may consist of suitable granular material that is placed in 8" or less lifts and compacted to at least 98% of the standard proctor maximum dry density (ASTM D 698) or flowable fill (Controlled Low Strength Material, CLSM). If flowable fill or lean concrete is utilized for backfill then the recommendation for overwidening the overexcavation is not necessary. Observation by a geotechnical engineer is recommended at the time of excavation to determine the presence and competency of the expected bearing strata and to document removal of unsuitable soils, if encountered. We suggest that a unit price be obtained for overexcavation and replacement prior to construction in the event that remediation is required during the foundation construction phase of the project. If the final grading plan differs from our presumptions at the time of this report, we should be consulted to review how the changes may impact our recommendations.



Footing excavations should be made to the required lines and grades as rapidly as possible. We recommend that footing excavations be left open for a minimum of time to prevent disturbance to the foundation soils. Foot traffic should be prevented on the base of the footing excavations if disturbance is noted. Hand cleaning, if required and setting of reinforcing steel should then be accomplished from the sides of the excavation. Surface drainage from the site and gutter/roof drainage from the existing structures should be diverted away from the construction area during construction activities.

Based on the soils encountered in the borings and our interpretation of site conditions, the lateral footing capacity, due to base shear, should be calculated using an allowable coefficient of friction between the base of the footing and the soil of 0.35. Passive resistance is formed as an object (shear key, footing, pile cap, etc.) plows through the soil. All calculations of passive resistance are based on the condition that the soil on the passive side of the footing will always be present. If at some future time, some of the soil on the passive side is removed, the passive resistance will decrease. Therefore, the possibility of some soil being removed should be considered when determining passive resistance to lateral loads.

If a minimum of 3 feet of soil is present, an equivalent fluid pressure of 225 pounds per cubic foot may be used to calculate the net allowable passive soil resistance. For less than 3 feet of soil passive resistance should not be used. The ground surface adjacent to the wall or footing should be horizontal in the direction of movement to a distance equal to at least twice the embedment depth. If the ground is sloped downwards away from the structure, a reduced equivalent fluid pressure should be used.

## 7.1 Middle School Classroom

For the Middle School Classroom, continuous bearing wall footings may be proportioned for a maximum net allowable soil pressure (FS=3) of 2,000 P.S.F., while spread footings may be proportioned for a maximum net allowable soil pressure (FS=3) of 2,500 P.S.F. The net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. Spread footings should be a minimum of 36 inches in the least dimension, while continuous bearing wall footings should be at least 24 inches wide. A summary of the foundation recommendations is shown below:

Table 4a: Foundation Recommendation Summary - Middle School Classroom

| Description                     | Continuous Bearing Wall Footings                             | Isolated Column Footings                                     |
|---------------------------------|--------------------------------------------------------------|--------------------------------------------------------------|
| Net Allowable Soil Pressure     | 2,000 PSF                                                    | 2,500 PSF                                                    |
| Minimum Width, in.              | 24"                                                          | 36"                                                          |
| Recommended Founding Depth      | Nominal Depth Interior, 36"<br>below Finished Exterior Grade | Nominal Depth Interior, 36"<br>below Finished Exterior Grade |
| Coefficient of Sliding Friction | 0.35                                                         |                                                              |

Below the building foundations, the recent fill should be removed to natural soils, where encountered. The presence of high plastic soils and variable recent fill at the elevations presumed for the floor slab subgrade will necessitate over-excavation and replacement or placement of a low volume change material in order to reduce post construction heaving associated with volume changes in the high plastic soils. The recommendations for floor slab over-excavation are described in the **Floor Slab and Site Earthwork Recommendations** section of this report.

## 7.2 Athletic Track/Field Improvement Foundations

For the Track/Field Building Improvements, foundations for buildings and other structures may be proportioned for a maximum net allowable soil pressure of 2,000 P.S.F. (FS=3). The net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. Spread footings should be a minimum of 30" in the least dimension, while continuous bearing wall footings should be at least 18 inches wide. A summary of the foundation recommendations is shown below:

Table 4b: Foundation Recommendation Summary – Athletic Track/Field Improvement Building Foundations

| Description                     | Continuous Bearing Wall Footings                          | Isolated Column Footings                                  |
|---------------------------------|-----------------------------------------------------------|-----------------------------------------------------------|
| Net Allowable Soil Pressure     | 2,000 PSF                                                 |                                                           |
| Minimum Width, in.              | 18"                                                       | 30"                                                       |
| Recommended Founding Depth      | Nominal Depth Interior, 36" below Finished Exterior Grade | Nominal Depth Interior, 36" below Finished Exterior Grade |
| Coefficient of Sliding Friction | 0.35                                                      |                                                           |

Unsuitable (soft or unstable) soils and recent fill, if encountered, should be removed from the footing excavations, and consequently replaced with suitable material as recommended. The presence of high plastic soils in the floor slab subgrades will necessitate over-excavation and replacement or placement of a low volume change material in order to reduce post construction heaving associated with volume changes in the high plastic soils. The recommendations for floor slab over-excavation are described in the **Floor Slabs and Site Earthwork Recommendations** section of this report.

## 8.0 FLOOR SLAB AND SITE EARTHWORK RECOMMENDATIONS

### 8.1 Building Floor Slabs Recommendations

The presence of high plastic clay soils and variable recent fill near the anticipated floor slab elevations will necessitate the placement of at least 30 inches of low volume change (LVC) material below slabs on grade. The capillary break may be considered part of the low volume change material.

The LVC material may consist of on-site or off-site suitable materials such as lean clay (LL=45% or less and PI=25% or less) or granular material. Granular material, if used, should have a maximum size of approximately 1 inch and not more than approximately 15% non-plastic fines. Without removal of the high plastic clay soils below the building floor slab the risk of shrink/swell with fluctuations of moisture content is increased. Consideration may be given to slab elevation adjustment to optimize LVC recommendations due to high plastic clay, when applicable.

Topsoil should be removed from the subgrade and fill areas prior to the commencement of earthwork activities and stockpiled for possible use for finish grading, if desired. Once the limit of the overexcavation is reached, the exposed surface should be thoroughly compacted with suitable compaction equipment prior to backfilling. Construction debris and any foreign material should be removed, if encountered. During site grading it is recommended that the top 12 inches of the floor slab subgrades below new LVC or structural fill be proofrolled and/or compacted to at least 95% of the standard proctor maximum (ASTM D698) dry density at moisture contents of optimum to 5% above optimum. Soft and/or unstable areas revealed by the proofrolling/compacting process should be excavated, reworked, and then be recompacted or removed and replaced with suitable material as necessary. Additional effort may be required to rework and recompact the soils within the zone of seasonal moisture variation. Close attention should be given to the subgrade preparation to reduce instability associated with the natural high plastic soils; the subgrade should be brought to an adequately moistened condition prior to the placement of structural fill and/or backfill and should be subsequently protected from drying prior to construction. Limiting the amount of soil drying during construction is critical in limiting the potential for shrinking and swelling of the subgrade and structural fill soils during post construction periods. Consequently, placement of moisture conditioned fill material should begin immediately upon completion of the excavations and subgrade testing/verification to reduce the potential for drying and/or disturbance of the underlying subgrade.

Moderate to high plastic soils found in the upper 5 feet of the native soils and recent fill soils should not be used as structural fill within 30 inches of the bottom of floor slabs. Structural fill and/or backfill (below the LVC) and the LVC required for the building slabs should be compacted to a dry density of at least 95% of the standard proctor maximum dry density (ASTM D 698) and the moisture content should be controlled within a range of 2% below to 4% above optimum. Field density tests in the existing re-worked subgrade, new granular fill, structural fill and/or backfill are recommended at the rate of one per 5,000 square feet per lift for areal fills and at the rate of one test per 100 feet per lift of wall and/or trench backfill. A summary of the compaction recommendations follows:

Table 5: Compaction Recommendation Summary – Building Floor Slabs

| Description                     | ASTM D 698 | Moisture Content from Optimum |
|---------------------------------|------------|-------------------------------|
| Building Subgrades (Top 12")    | 95%+       | 0% to +5%                     |
| Structural Fill/LVC             | 95%+       | -2% to +4%                    |
| Footing Overexcavation Backfill | 98%+       | ±2%                           |

Floor slabs should be provided with adequate crack control joints and separated from the foundation system to accommodate vertical slab movements due to minor volume changes in the subgrade. The floor slab should be provided with a layer of free draining granular base such as crushed limestone and it should not contain more than 5% fines. We further recommend that a polyethylene moisture barrier be provided between the granular base or LVC and the floor slabs to reduce moisture transmission through the concrete floors and to reduce the potential for concrete curling.

The site grading plan should provide for positive surface water drainage away from the proposed structure(s) and roof drains should connect to watertight lines that extend away from the building(s). All drain or utility lines beneath floors should have tight joints to prevent leakage. Large trees and shrubs should not be planted adjacent to exterior footings, as these plants can cause drying and shrinkage of foundation soils. Surface drainage/runoff and gutter/roof drainage from the existing nearby building should be diverted away from the site construction area during construction activities.

## **8.2 Synthetic Field Turf Subgrade Recommendations**

Based on the field and laboratory data and our experience with similar soils, we estimate potential vertical rise (PVR) values at the boring locations to be up to approximately 1½ inches. If a reduction of the PVR value to 1 inch or below is required for the existing soils we recommend a low volume change (LVC) layer of at least 24 inches in thickness. The LVC material may consist of suitable materials such as lean clay (LL=40% or less and PI=20% or less), chemically modified soil, or granular material. Granular material, if used, should have a maximum size of approximately 1 inch and not more than approximately 15% non-plastic fines.

Topsoil should be removed from subgrades and areas to receive new structural fill prior to scarifying and re-working the existing subgrade. Care should be taken to remove all recent fill soils that contain organic material (if any are observed during grading). During site grading it is recommended that the subgrade below new structural fill or drainage material be proofrolled and compacted to at least 95% of the standard proctor maximum dry density but not more than the standard maximum dry density at moisture contents of optimum to 5% above optimum. Additional effort may be required to rework and recompact the soils within the zone of seasonal moisture variation. Foreign material found within the recent fill larger than 3 inches should be removed from the subgrade.

During seasonally wet weather periods, there will be some locations of the subgrade soils that are wet of optimum moisture and would require drying of the excess moisture to achieve the recommended degree of compaction. Conversely, dry weather periods will result in drier than optimum conditions that will necessitate adding moisture and reworking. Soft, unsuitable and/or unstable areas of the subgrade revealed during the proofrolling process should be removed and replaced with suitable material and compacted as previously recommended.

Close attention should be given to the subgrade preparation to reduce instability; the subgrade should be brought to an adequately moistened condition prior to the placement of structural fill and/or backfill and should be subsequently protected from drying prior to construction. Limiting the amount of soil drying during construction is critical in limiting the potential for shrinking and/or swelling of the subgrade and structural fill soils during post construction periods due to moisture changes. Consequently, placement of moisture conditioned fill material should begin immediately upon completion of the excavations and subgrade testing/verification to reduce the potential for drying and/or disturbance of the underlying subgrade.

Structural fill and/or backfill (below the LVC) and the LVC, if required, for the synthetic turf subgrade should be compacted to a dry density of at least 95% of the standard proctor maximum dry density (ASTM D 698) and the moisture content should be controlled within a range of 1% below to 4% above optimum. Field density tests in the existing re-worked subgrade, new granular fill or LVC, structural fill and/or backfill are recommended at the rate of one per 10,000 square feet per lift for areal fills.

For the field turf subgrade, if LVC is required to lower the PVR, consideration may be given to stabilization of the on-site or any imported clay soils not meeting the plasticity recommendations using quick lime, hydrated lime or the lime by-product, Code L (also known as lime kiln dust). Fill or subgrade soils to be stabilized with lime should be thoroughly pulverized by either rotary speed mixing or a discing method approved by the engineer so that all soil will pass a 2-inch sieve. Quick lime should be spread at a rate of at least 3 percent by dry weight of the soil (hydrated lime of 4 percent and at least 5 percent by dry weight if the lime by-product Code L is used). The lime should be spread evenly with a drag, by hand rakes, automated spreader, or other approved method before mixing. Spreading with a highlift or grader is not recommended. Mixing and pulverizing should continue until 100 percent of the mix passes a 1-inch sieve and 60 percent passes the #4 sieve. After pulverization, the fill and/or stabilized subgrade should be compacted to at least 95 percent of the standard proctor maximum dry density at moisture contents of 2% below to 5% above optimum moisture content. During this process, water may need to be added to the soil to raise the water content above the optimum value.

Lower ambient air temperatures will slow the hydration process and require longer curing periods. Experience has shown that curing times increase significantly below about 40°F. The lime or Code L should not be exposed to the air for extended periods. Excessive exposure can cause lime carbonation and cause the lime to become drastically less effective for the intended purpose. Lime should be used within two days of delivery to the site and adequately protected from the elements. Lime stabilization works well with moderately and high plastic clay soils such as those in the upper part of the soil profile at this site. Stabilization of silty low plasticity clays from on or off-site will not necessarily yield a favorable result, therefore, the material composition from off-site sources should be carefully screened before choosing a stabilization plan. If properly constructed, lime stabilized clay can significantly improve site surface conditions, allow for winter construction and reduce off-site mud problems from the site into nearby areas.



The subsurface drainage base layer should be provided with a layer of free draining granular base such as crushed limestone and it should not contain more than 5% fines. The site grading plan should provide for positive surface water drainage to prevent pooling and/or ponding of surface water. A summary of the compaction recommendations follows:

Table 6: Compaction Recommendations Summary – Synthetic Field Turf

| Description                                      | ASTM D 698 | Moisture Content from Optimum |
|--------------------------------------------------|------------|-------------------------------|
| Turf Subgrade (Top 12")                          | 95-100%    | 0% to +5%                     |
| Structural Fill/LVC                              | 95%+       | -1% to +4%                    |
| Chemically Modified Soils (i.e. Lime Stabilized) | 95%+       | -2% to +5%                    |

### 8.3 Synthetic Athletic Track Subgrade Recommendations

The results of the geotechnical investigation, based on the in-situ field test results, indicate that the replacement track subgrade may be designed using a seasonally adjust CBR value of 2½%. In areas of track replacement overlying existing granular base, if encountered, we recommend the existing granular material remain in place and that the placement of a geogrid beneath new granular base be constructed in order to provide separation and reinforcement. Tensar® TX 140 or equivalent would be suitable for this application. Manufacturer's guidelines suggest that at least 6 inches of aggregate base be used above the geogrid. Care should be taken to avoid damaging the existing aggregate base and subgrade during the placement of the geogrid and aggregate base. If damage occurs due to lack of aggregate base thickness in existing areas of the track or due to the presence of soft subgrade soils, reference the recommendations following for the track expansion.

In areas of the track expansion/re-location, topsoil should be removed from subgrades and areas to receive new structural fill prior to scarifying and re-working the subgrade. During site grading it is recommended that the subgrade below new structural fill or aggregate base be thoroughly proof-rolled and compacted to a depth of at least 12" and to a minimum of 97% of the standard proctor maximum dry density as established by ASTM D 698 and at moisture contents of 3% below to 3% above optimum. Additional effort may be required to re-work and re-compact the soils within the zone of seasonal moisture variation. Dry weather may result in drier than optimum conditions that will necessitate adding moisture and reworking, while wet weather will result in scarifying and drying then recompacting. Soft, unsuitable and/or unstable areas of the subgrade should be removed and replaced with suitable material and compacted as recommended or chemically modified following recommendations as previously recommended.

New structural fill (if any) should be compacted to at least 95% of the standard proctor maximum dry density at moisture contents within -2% to +4% of optimum moisture content. Field density tests in the subgrade and new structural fill and/or backfill are recommended at the rate of one test for every 250 linear feet per lift. The site grading plan should provide for positive surface water drainage away from the track surface and subgrade. Due to the high plastic clay in the natural soils, we recommend that at least 6" of granular base be placed under the areas of the expanded track surface overlying geogrid as recommended above. New aggregate base for the track expansion/replacement should be compacted to a minimum density of 98% of the maximum dry density (ASTM 698) at  $\pm 2\%$  of optimum. A summary of the compaction recommendations follows:

Table 7: Compaction Recommendations Summary – Synthetic Athletic Track Subgrade

| Description                                      | ASTM D 698 | Moisture Content from Optimum |
|--------------------------------------------------|------------|-------------------------------|
| Track Subgrade (Top 12")                         | 97%+       | $\pm 3\%$                     |
| Structural Fill                                  | 95%+       | -2% to +4%                    |
| Aggregate Base (Track)                           | 98%+       | $\pm 2\%$                     |
| Chemically Modified Soils (i.e. Lime Stabilized) | 95%+       | -2% to +5%                    |

Equipment utilized for the placement of the aggregate base and track surface should be proportioned to minimize possible damage to the underlying subgrade during construction of the track pavement system. Damage caused during the placement of the aggregate base or new track surface for the track expansion should be repaired as recommended above prior to placement of material. The aggregate base course should conform to the gradation requirements of MoDOT Type 5 gradation subbase material. Proper slope of the track subgrade and surface to achieve adequate drainage is crucial for the track surface life span. Regular maintenance should be performed on the track surface to reduce the potential deterioration due to moisture infiltration through surface cracking.

## 9.0 ESTIMATED SITE SOIL PARAMETER RECOMMENDATIONS (ATHLETIC TRACK/FIELD AND IMPROVEMENTS)

Estimates of the pertinent soil parameters are recommendations for use as ultimate values and contain a factor of safety of 1.0. The borings revealed relative strata uniformity therefore we have estimated values based on averaged data from the borings. The soil layers are classified according to the primary material within the zone identified, as most apparent in the retrieved samples; please reference the boring logs. The estimated average soil parameter values follow:

Table 8: Average Soil Parameter Estimates Summary – Athletic Track/Field and Improvements

| Depth (ft.) | Cohesion (PSF) | Total Unit Weight, P.C.F. | Ka   | Ko   | Kp   | Soil Type |
|-------------|----------------|---------------------------|------|------|------|-----------|
| 0-5         | 750            | 115                       | 0.49 | 0.66 | 2.04 | CL/CH     |
| 5-15        | 1,500          | 124                       | 0.53 | 0.69 | 1.89 | CH/CL     |

## 10.0 TEMPORARY EXCAVATIONS RECOMMENDATIONS

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Temporary excavations should be constructed in accordance with OSHA regulations. The soils at the site classify as OSHA Type B and excavations extending less than 20 feet in vertical height into these soils should be cut on a slope no steeper than 1H:1V. Flatter slopes may be required and all operations should be performed under the supervision of qualified site personnel in accordance with OSHA regulations. Excavations deeper than 20 feet must be designed by a registered professional engineer and, based on our understanding of the project are not anticipated. Excavation slopes left exposed should be protected from erosion and saturation by rainfall and runoff.

## 11.0 PAVEMENT SUBGRADE RECOMMENDATIONS

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We presume that the pavement section(s) will consist of either flexible (hot-mix asphalt) or portland cement concrete over a compacted aggregate base course and compacted soil subgrade. The subgrade in some areas to be paved may be comprised of recent fill, the soils should be observed for construction debris and other forms of foreign material during excavations and at the subgrade surface; removal of objectionable material is recommended. Structural fill required for the pavement areas should be compacted to a dry density of at least 95% of the standard proctor maximum dry density (ASTM D 698) and the moisture content should be controlled within a range of 2% below to 4% above optimum.

The subbase for all paved areas should be thoroughly proofrolled and compacted to a depth of at least 12" and to a minimum dry density of 98% of the maximum dry density as established by ASTM D 698 and within a moisture content range of  $\pm 2\%$  of optimum. We further recommend that the granular base under the pavement be compacted to a minimum density of 100% of the maximum dry density (ASTM 698) and the moisture content should be controlled within a range of  $\pm 2\%$  of optimum. Pavement subgrades should undergo the proofrolling process to help in identifying soft or unstable areas; remediation should follow our previous recommendations. We recommend a bearing ratio (CBR) of 3%, and a subgrade reaction modulus (k) of 100 P.S.I./in., may be used in design of pavement sections founded in natural, on-site soils prepared and compacted as recommended herein. A summary of the compaction recommendations follows:



Table 9: Compaction Recommendation Pavement Section Summary

| Description                  | ASTM D 698 | Moisture Content from Optimum |
|------------------------------|------------|-------------------------------|
| Structural Fill for Pavement | 95%+       | -2% to +4%                    |
| Pavement Subbase (Top 12")   | 98%+       | ±2%                           |
| Pavement Base (Aggregate)    | 100%+      | ±2%                           |

During proofrolling, permanent rutting in excess of 1 inch should be considered failure. Elastic (rebound) movement or rutting in excess of 1 inch with substantial cracking or substantial lateral movement should be considered failure. Rutting and cracking greater than detailed above is considered "pronounced elasticity". Elastic, rebound, or rolling movement is always associated with excess water in the subgrade system. Failing areas detected by proofrolling should be removed and replaced with suitable material as previously recommended. Areas of pavement subgrades that do not respond to proofrolling and recompaction may be amended by the use of chemical admixtures (i.e. lime product) and/or commercially available subgrade reinforcing geogrids such as Tensar® TX 160. The aggregate base course should conform to the gradation requirements of MoDOT Type 5 Base.

We recommend the use of a geogrid beneath the granular base in order to provide separation and reinforcement if utilizing a flexible pavement design. Tensar® TX 7 or equivalent would be suitable for this application and it will reduce the amount of overexcavation resulting from subgrade instability. Manufacturer's guidelines suggest that at least 6 inches of aggregate base be used above the geogrid. If rigid pavement is selected we recommend the use of a geotextile fabric beneath the granular base in order to improve subgrade drainage and to provide separation and drainage from the underlying fine-grained soils. Mirafi 160N or equivalent would be suitable for this application. We recommend following the manufacturer's guidelines for installation and overlap procedures. If chemical modification is utilized in the pavement subgrade to a depth of at least 12", the recommendation for the geogrid does not apply.

For the pavement base, consideration may be given to stabilization of the on-site soils using quick lime or hydrated lime. Fill or subgrade soils to be stabilized with lime should be thoroughly pulverized by either rotary speed mixing or a discing method approved by the engineer so that all soil will pass a 2-inch sieve. Quick lime should be spread at a rate of at least 3 percent by dry weight of the soil (hydrated lime of 4 percent). The lime should be spread evenly with a drag, automated spreader, or other approved method before mixing. Spreading with a highlift or grader is not recommended. Mixing and pulverizing should continue until 100 percent of the mix passes a 1-inch sieve and 60 percent passes the #4 sieve. After pulverization, the fill and/or stabilized subgrade should be compacted to at least 95 percent of the modified proctor maximum dry density. During this process, water may need to be added to the soil to raise the water content above the optimum value.

Lower ambient air temperatures will slow the hydration process and require longer curing periods. Experience has shown that curing times increase significantly below about 40°F. The lime should not be exposed to the air for extended periods. Excessive exposure can cause lime carbonation and cause the lime to become drastically less effective for the intended purpose. Lime should be used within two days of delivery to the site and adequately protected from the elements. Lime stabilization works well with moderately and high plastic clay soils such as those in the upper part of the soil profile at this site. Stabilization of silty low plasticity clays from on or off-site will not necessarily yield a favorable result, therefore, the material composition from off-site sources should be carefully screened before choosing a stabilization plan. If properly constructed, lime stabilized clay can significantly improve site surface conditions, allow for winter construction, reduce off-site mud problems from the site into nearby areas and reduce the required pavement sections. If chemical stabilization is utilized we recommend a bearing ratio (CBR) of 15% may be used in design of pavement subgrade prepared and compacted as recommended.

It should be noted that some of the subgrade soils may be wet of optimum dependent upon the time of year during construction. Therefore, reworking and recompaction may be necessary and may require considerable effort. Consideration should be given to heavy-duty concrete pavement at entrances, near trash dumpsters, loading docks and/or areas of repeated truck traffic. We recommend drains be provided around catch basins and low parts of the roadway to minimize the accumulation of water in the subgrade soils. Proper slope of the pavement subgrades and pavement surfaces to achieve adequate drainage is crucial in pavement life span. Regular maintenance should be performed on the pavement surfaces to reduce the potential deterioration due to moisture infiltration through surface cracking.

## 12.0 SEISMICITY

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Based on the subsurface conditions encountered and our understanding of the areal geology, the site class is closest to C in accordance with IBC 2015. Seismic site classification is based on soil data in the top 100 feet below grade.

The calculated maximum considered earthquake spectral response accelerations for short periods value  $S_s = 0.160$  ( $MCE_R$  ground motion (period = 0.2s)) and for one second  $S_1 = 0.091$  ( $MCE_R$  ground motion (period = 1.0s)). The calculated site-modified spectral acceleration value  $S_{ms} = 0.192$  and the calculated site-modified spectral acceleration value  $S_{m1} = 0.155$ . The factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years)  $S_{sUH} = 0.185$  and  $S_{1UH} = 0.109$ . Liquefaction potential for the site is low, although some vertical and horizontal displacement should be expected during a major earthquake. A summary of the seismicity value recommendations follows:

Table 10: Seismicity Value Estimates Summary

| Description | Value Estimate |
|-------------|----------------|
| $S_{ms}$    | 0.192          |
| $S_{m1}$    | 0.155          |
| $S_s$       | 0.160          |
| $S_1$       | 0.091          |
| $S_{sUH}$   | 0.185          |
| $S_{1UH}$   | 0.109          |

## 13.0 CONCLUSIONS

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The geotechnical investigation, including exploration, testing, and analyses has been completed for the proposed New Middle School Classroom, Athletic Track/Field and Improvements at the existing Hallsville School campus in Hallsville, Missouri. Foundation, slabs on grade, backfill, subgrade, pavement subgrade, soil parameter estimates, seismicity, and related site earthwork recommendations, based on the investigation, have been included in this report. The analyses, conclusions and recommendations contained in this report are based on the site conditions and project descriptions presented in this report, and the subsurface conditions disclosed by the exploratory borings.

The conclusions and recommendations presented are professional opinions based on the above conditions, professional judgment and experience. If during design and construction, changes occur, either in the proposed construction, due to natural causes or construction operations at the site, from a substantial lapse in time, or should subsurface conditions encountered during construction differ materially from those presented, we should be contacted to review any changes in circumstances and conditions to evaluate the effects on the analyses, conclusions and recommendations presented.

The borings were placed to obtain a reasonable picture of the subsurface conditions. However, variations in the subsurface conditions not indicated by the borings are always possible. These data are supplied for the benefit of the designers and owner and do not express or imply any warranty of the subsurface conditions. Completed foundation excavations, foundation construction, pavement subgrade and pavement construction and backfill construction should be observed and tested during the construction phase by a qualified professional to verify the subsurface conditions and the design assumptions.

The scope of our services does not include environmental assessment of investigation for the presence or absence of hazardous or toxic materials in the soil, groundwater or surface water within the site studied. Any statements in this report regarding odors, staining of soils, or other unusual conditions observed are strictly for the information of our client.

# **APPENDIX A**

## **TEST BORING LOCATION IMAGE**



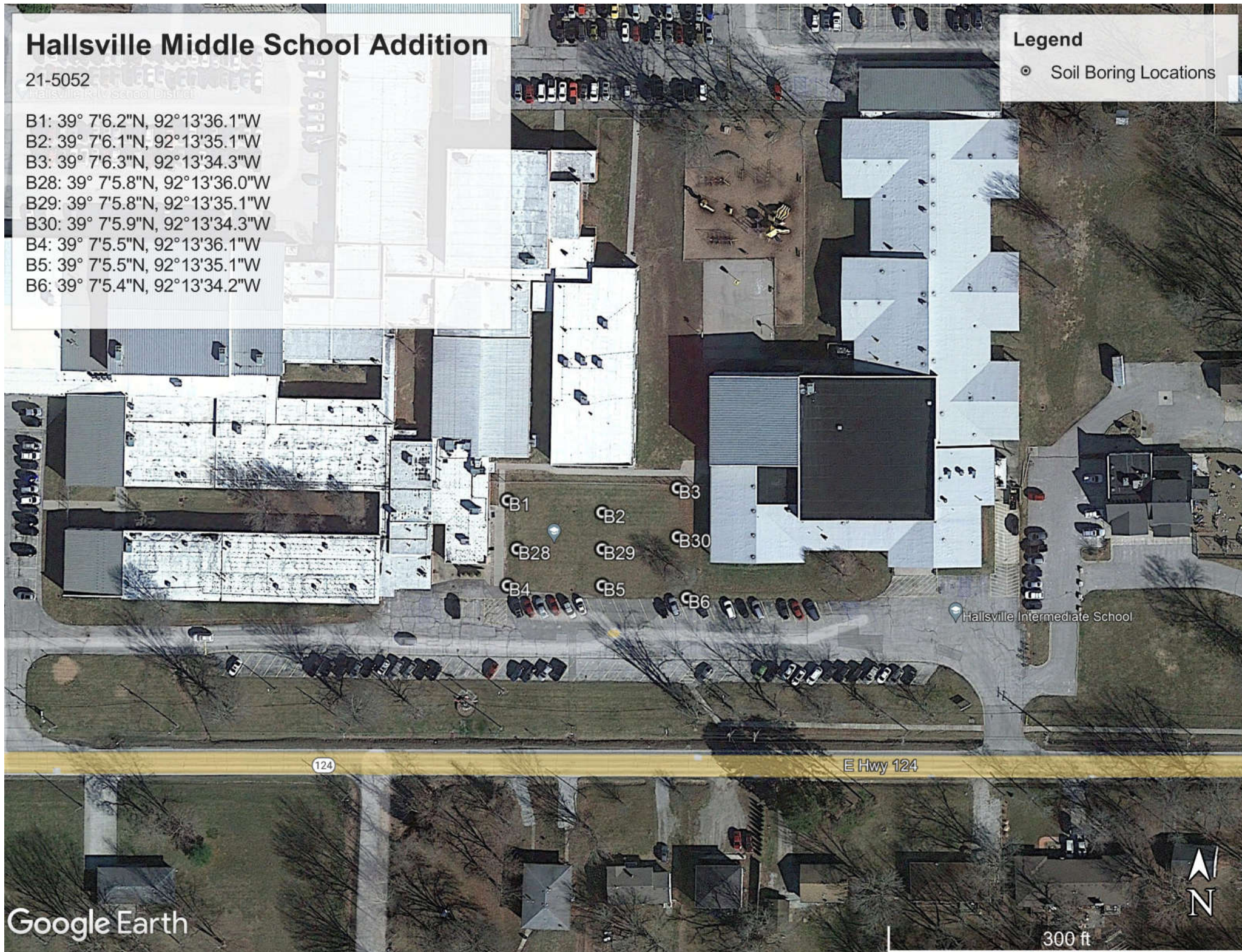
# Hallsville Middle School Addition

21-5052

B1: 39° 7'6.2"N, 92°13'36.1"W  
B2: 39° 7'6.1"N, 92°13'35.1"W  
B3: 39° 7'6.3"N, 92°13'34.3"W  
B28: 39° 7'5.8"N, 92°13'36.0"W  
B29: 39° 7'5.8"N, 92°13'35.1"W  
B30: 39° 7'5.9"N, 92°13'34.3"W  
B4: 39° 7'5.5"N, 92°13'36.1"W  
B5: 39° 7'5.5"N, 92°13'35.1"W  
B6: 39° 7'5.4"N, 92°13'34.2"W

## Legend

○ Soil Boring Locations





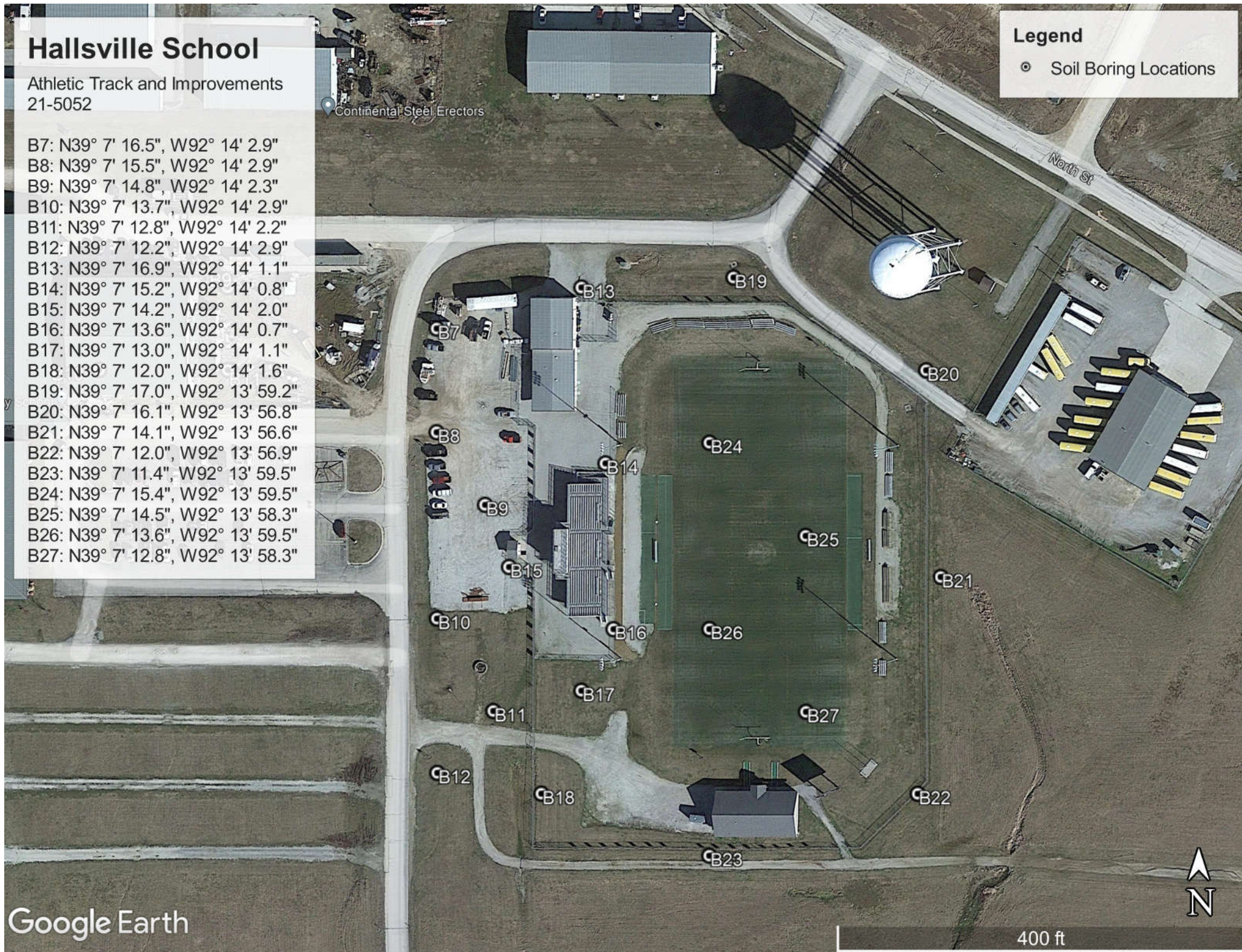
# Hallsville School

Athletic Track and Improvements  
21-5052

B7: N39° 7' 16.5", W92° 14' 2.9"  
B8: N39° 7' 15.5", W92° 14' 2.9"  
B9: N39° 7' 14.8", W92° 14' 2.3"  
B10: N39° 7' 13.7", W92° 14' 2.9"  
B11: N39° 7' 12.8", W92° 14' 2.2"  
B12: N39° 7' 12.2", W92° 14' 2.9"  
B13: N39° 7' 16.9", W92° 14' 1.1"  
B14: N39° 7' 15.2", W92° 14' 0.8"  
B15: N39° 7' 14.2", W92° 14' 2.0"  
B16: N39° 7' 13.6", W92° 14' 0.7"  
B17: N39° 7' 13.0", W92° 14' 1.1"  
B18: N39° 7' 12.0", W92° 14' 1.6"  
B19: N39° 7' 17.0", W92° 13' 59.2"  
B20: N39° 7' 16.1", W92° 13' 56.8"  
B21: N39° 7' 14.1", W92° 13' 56.6"  
B22: N39° 7' 12.0", W92° 13' 56.9"  
B23: N39° 7' 11.4", W92° 13' 59.5"  
B24: N39° 7' 15.4", W92° 13' 59.5"  
B25: N39° 7' 14.5", W92° 13' 58.3"  
B26: N39° 7' 13.6", W92° 13' 59.5"  
B27: N39° 7' 12.8", W92° 13' 58.3"

## Legend

⊙ Soil Boring Locations





**APPENDIX B**  
**FIELD AND LABORATORY**  
**INVESTIGATION GENERAL**  
**INFORMATION**

## **FIELD INVESTIGATION**

The field investigation consisted of site observation, subsurface exploration and sampling, as well as field testing and visual classification of the soils encountered in accordance with ASTM specifications. The site observation provided information concerning existing topography and recent manmade alterations, if any were observed. During the investigation the locations and ground elevations for each of the borings were determined, unless provided by others. Subsurface exploration and sampling was conducted in an effort to define the soil profile and to obtain disturbed and/or undisturbed representative samples of the various soils encountered for the purpose of the laboratory investigation.

Dependent upon the field conditions and project requirements, test borings were completed with a CME 75 truck mounted or CME 55 track mounted drill rig equipped with either 3¼ or 4¼ inch I.D. hollow stem augers in accordance with ASTM D6151, 5 inch solid stem augers in accordance with ASTM D1452, or rotary drilling equipment in accordance with ASTM D5783. The hollow stem augers permit convenient access to the undisturbed soil below the auger bit which allows the driller to obtain a soil sample at the desired depth. The boreholes upon completion were backfilled with auger cuttings (soil) and boring plug (if requested). Periodic observation and maintenance of the backfilled boreholes should be performed to monitor for subsidence at the ground surface as the borehole backfill could settle over time.

As the test borings were advanced, methods of sampling were employed to recover soils from the undisturbed strata below the auger bit. Representative disturbed samples were obtained from a standard Split Spoon and the samples were recovered by driving a 2 inch O.D. (1 3/8 inch I.D.) Split Spoon sampler in accordance with ASTM D1586. When subsurface conditions warranted, relatively undisturbed samples were obtained in cohesive soils by hydraulically pushing a thin walled seamless tube sampler into the soil in accordance with ASTM D1587. The Shelby Tubes were 2 or 3 inches in outside diameter depending upon the project requirements. One or both of these methods may have been utilized based on site conditions and/or job specific requirements. Additionally, disturbed samples collected from auger cuttings in accordance with ASTM D1452 may have been obtained as needed to further facilitate identification of the subsurface conditions.

The recovered samples were described in the field according to color, texture, grain size, plasticity and consistency, as recommended by ASTM D2488, "Description and Identification of Soils (Visual-Manual Procedure)". Split Spoon samples when obtained were sealed/preserved in glass jars and labeled while Shelby Tube samples, when obtained, were sealed/preserved within the tubes and also labeled prior to transporting to our laboratory. Auger cuttings, when obtained, were sealed in an air tight container to preserve the natural moisture content. The samples were all carefully stored, preserved, and transported for later use in the laboratory testing program in general accordance with ASTM D4220.

Field tests were conducted in an effort to estimate the shearing strength of the soil. Though the results of these tests were not used alone as a basis for shearing strength determination, they were helpful in predicting the behavior of the soil mass and should only be considered an approximate estimation. Where applicable, further laboratory testing and evaluation in conjunction with the field testing program was essential in determining the soil conditions.



The field testing program included the Standard Penetration Test conducted in accordance with ASTM D 1586. In this test, administered during the Split Spoon sampling procedure, a 2 inch O.D. (1 3/8 inch I.D.) 24 inch long standard Split Spoon was driven into the soil through a depth of 18 inches by a 140 pound weight dropped a distance of 30 inches. The penetration resistance, "N", was recorded as the number of blows, from the falling weight, required to drive the sampler through the final 12 inches. This penetration resistance provided a measure of the apparent relative density of cohesionless soils and an estimate of the consistency of cohesive materials.

Recovered cohesive samples were tested, when possible, by the use of a calibrated pocket penetrometer. The values from this test were considered an approximate measure of the consistency of the cohesive soils. The penetrometer values as well as the measures of penetration resistance were later correlated with the results of the laboratory tests conducted on cohesive soil samples obtained from the Split Spoon and/or Shelby Tube samples.

The results of the field tests on each soil sample, as well as the soil descriptions, were recorded on field boring logs in accordance with ASTM D 5434 as the subsurface exploration progressed. These field boring logs were later modified to reflect the more elaborate analysis provided by the laboratory testing program. These modified field boring logs are the final boring logs that are attached to this report.

## **LABORATORY INVESTIGATION**

The laboratory investigation involved the completion of classification tests on select undisturbed samples as well as select disturbed samples of the soils that were obtained from the various soil layers encountered beneath the site. Based on the field logs/records and our examination of the samples in the laboratory, a soil testing program was developed to acquire more precise estimations and detailed information about the soil conditions at the site.

Representative samples from the various soil strata were tested (site specific determination) in accordance with ASTM specifications. Dependent upon the sample availability and project requirements the laboratory testing on select representative samples included such soil index testing as natural moisture content (ASTM D2216), atterberg limits testing (ASTM D4318) and grain size analysis (ASTM D422). These parameters were used in identifying the soils through the Unified Soil Classification System in accordance with ASTM D 2487. This System, which is standardized and widely accepted, enables the Geotechnical Engineer to classify a soil using quantitative test results. A brief description of this classification system is contained in this report. Estimated predictions of the soil behavior during and after construction may readily be made through the use of this comparative type of classification.

Disturbed Split Spoon and/or relatively undisturbed Shelby Tube samples of cohesive soils were tested to determine unit weight and an approximation of the unconfined compressive strength. These tests were conducted with controlled strain by the use of a hand-operated compression apparatus with a double proving ring in accordance with ASTM D 2166. The results of some of the tests must be considered cautiously, recognizing that Split Spoon samples are disturbed and when tested, will generally provide slightly conservative values in relation to the probable conditions in the field. The relatively undisturbed Shelby Tube samples, however, should approach more closely the condition of the soils in-situ and the results of unconfined compression tests on these samples are typically considered to be fairly indicative of the in-situ soil conditions. When indicated, the undrained shear strength of saturated fine-grained soils was estimated utilizing the miniature vane shear test in accordance with ASTM D4648.

Additional laboratory testing in accordance with ASTM standards such as specific gravity, moisture-density relationship, relative density, hydraulic conductivity, consolidation, direct shear, triaxial compression, among others, are utilized when applicable for project specific requirements. Upon completion of the laboratory testing program the final boring logs were prepared utilizing the data obtained from the laboratory testing and the initial data/records contained on the field boring logs. The remaining soil samples after the project testing is completed will be held for a minimum period of one month. After one month, the samples are typically discarded unless prior notification is provided to us.

## **B O R I N G L O G S**

### **GENERAL INFORMATION**

#### **I. DRILLING AND SAMPLING SYMBOLS:**

- HA - Hollow or Solid Stem Continuous Flight Auger Disturbed Samples
- SS - Split Spoon Sample (2" O.D. - 1 3/8" I.D.) Obtained Following the Standard Penetration Test
- 2ST - Shelby Tube Sample (2" O.D.)
- 3ST - Shelby Tube Sample (3" O.D.)

#### **II. SOIL IDENTIFICATION:**

The soils have been identified by Visual-Manual procedures in accordance with ASTM Standards (ASTM D 2488). Where specifically noted, the soils have been classified using the Unified Soil Classification System (ASTM D 2487). Classification estimates are in parentheses when applicable.

#### **RELATIVE PROPORTIONS OF SAND AND GRAVEL**

Descriptive Term(s) of Components Present in Sample by Percent of Dry Weight

|          |       |
|----------|-------|
| Trace    | <15   |
| With     | 15-29 |
| Modifier | >30   |

#### **RELATIVE PROPORTIONS OF FINES**

Descriptive Term(s) of Components Present in Sample by Percent of Dry Weight

|          |      |
|----------|------|
| Trace    | <5   |
| With     | 5-12 |
| Modifier | >12  |

## **GRAIN SIZE TERMINOLOGY**

Major Component of Sample and Size Range

|              |                        |
|--------------|------------------------|
| Boulders     | Over 12 in.            |
| Cobbles      | 12 in. to 3 in.        |
| Gravel       | 3 in. to #4 sieve      |
| Sand         | #4 sieve to #200 sieve |
| Silt or Clay | Passing #200 sieve     |

## **SOIL STRUCTURE TERMINOLOGY**

|               |                                                                                           |
|---------------|-------------------------------------------------------------------------------------------|
| Parting:      | Paper Thin in Size                                                                        |
| Seam:         | 1/8" to 3" in Thickness                                                                   |
| Layer:        | Greater than 3" in Thickness                                                              |
| Interbedded:  | Alternating Soil Type Layers                                                              |
| Laminated:    | Thin Layers of Varying Color and Texture, or Composition                                  |
| Slickensided: | Having Inclined Planes of Weakness that are Slick and Glossy in Appearance                |
| Fissured:     | Containing Shrinkage Cracking, Frequently Filled with Fine Sand or Silt, Usually Vertical |
| Ferrous:      | Containing Appreciable Iron                                                               |
| Desiccated:   | Soil that has been Subjected to a Thorough Drying Process                                 |

### **III. SOIL PROPERTY SYMBOLS:**

MC - Natural Moisture Content in %.

DRY WT.- Unit Dry Weight in Pounds per Cubic Foot.

LL - Liquid Limit in %.

PL - Plastic Limit in %.

PI - Plasticity Index in %

Qp - Unconfined Compressive Strength in Tons per Square Foot Calibrated Penetrometer Value

Qu - Unconfined Compressive Strength in Tons per Square Foot Obtained in Laboratory at Controlled Rate of Strain

**BLOWS** - The "blows" are the recorded results of the Standard Penetration Test (SPT). In this field test, a standard Split Spoon Sampler (2" O.D.- 1 3/8" I.D.) is driven into the soil for a total penetration of 18 inches by a 140-pound hammer which is repeatedly dropped freely for a distance of 30 inches.

The number of blows are recorded (field logs) for each 6 inches of penetration, and the penetration resistance, "N", is considered as the number of blows required for the last 12 inches of penetration.

**EXAMPLE:** 3-8-6 "N" = 14 blows/foot

The SPT "N" value for split-spoon refusal conditions is typically estimated as greater than 100 blows per foot. When split-spoon refusal occurs, often little or no sample is recovered.

For our own in-house purposes, refusal is estimated at 50 blows per 6 inches. Where the sampler is observed not to penetrate after 50 blows, the "N" value is reported as 50/0". Otherwise, the depth of penetration after 50 blows is reported in inches (i.e. 50/5", 50/2"). Should the sampler not penetrate the full 18 inches, the results are recorded as follows:

EXAMPLE: 6-21-50/3"

This means that 6 blows were required for the first 6 inches of penetration, 21 blows were required for the second 6 inches of penetration, and 50 blows were required for the last 3 inches of penetration.

▽ - Groundwater Level During Drilling

▼ - Groundwater Level at Indicated Hours Following Boring Completion

#### **IV. APPROXIMATE RELATIVE DENSITY AND CONSISTENCY OF SOILS ON THE BASIS OF THE STANDARD PENETRATION TEST:**

##### **NONCOHESIVE SOILS**

##### **BLOWS/FT.\*\* RELATIVE DENSITY**

|         |              |
|---------|--------------|
| 0 - 4   | Very Loose   |
| 4 - 10  | Loose        |
| 10 - 30 | Medium Dense |
| 30 - 50 | Dense        |
| 50+     | Very Dense   |

##### **COHESIVE SOILS\***

##### **BLOWS/FT \*\* CONSISTENCY**

|         |            |
|---------|------------|
| 0 - 2   | Very Soft  |
| 2 - 4   | Soft       |
| 4 - 8   | Medium     |
| 8 - 15  | Stiff      |
| 15 - 30 | Very Stiff |
| 30+     | Hard       |

\* Use with caution

\*\*Penetration Resistance "N"

#### **V. QUANTITATIVE EXPRESSIONS FOR THE CONSISTENCY OF CLAYS:**

##### **UNCONFINED COMPRESSIVE STRENGTH**

##### **CONSISTENCY T.S.F.**

##### **FIELD IDENTIFICATION**

|            |            |                                                                  |
|------------|------------|------------------------------------------------------------------|
| Very Soft  | 0.0 - 0.25 | Easily penetrated several inches by fist.                        |
| Soft       | 0.25 - 0.5 | Easily penetrated several inches by thumb.                       |
| Medium     | 0.5 - 1.0  | Penetrated by thumb with moderate effort.                        |
| Stiff      | 1.0 - 2.0  | Readily indented by thumb but penetrated only with great effort. |
| Very Stiff | 2.0 - 4.0  | Readily indented by thumbnail.                                   |
| Hard       | 4.0+       | Indented with difficulty by thumbnail.                           |

| MAJOR DIVISIONS                                                                                       |                                                                                                         |                                                     | GRAPH SYMBOL | GROUP SYMBOL | TYPICAL DESCRIPTIONS                                                                                           |
|-------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|-----------------------------------------------------|--------------|--------------|----------------------------------------------------------------------------------------------------------------|
| <b>COARSE GRAINED SOILS</b><br><br>More than 50% of Material is <b>LARGER</b> than No. 200 Sieve Size | <b>GRAVEL AND GRAVELLY SOILS</b><br><br>More than 50% of Coarse Fraction <b>RETAINED</b> on No. 4 Sieve | CLEAN GRAVELS<br>(Little or No Fines)               |              | GW           | Well-Graded Gravel, Gravel-Sand Mixture, Little or No Fines                                                    |
|                                                                                                       |                                                                                                         |                                                     |              | GP           | Poorly-Graded Gravel, Gravel-Sand Mixtures, Little or No Fines                                                 |
|                                                                                                       |                                                                                                         | GRAVELS WITH FINES<br>(Appreciable Amount of Fines) |              | GM           | Silty Gravel, Gravel-Sand-Silt Mixtures                                                                        |
|                                                                                                       |                                                                                                         |                                                     |              | GC           | Clayey Gravel, Gravel-Sand-Clay Mixtures                                                                       |
|                                                                                                       | <b>SAND AND SANDY SOILS</b><br><br>More than 50% of Coarse Fraction <b>PASSING</b> on No. 4 Sieve       | CLEAN SAND<br>(Little or No Fines)                  |              | SW           | Well-Graded Sand, Gravely Sands, Little or No Fines                                                            |
|                                                                                                       |                                                                                                         |                                                     |              | SP           | Poorly-Graded Sand, Gravely Sands, Little or No Fines                                                          |
|                                                                                                       |                                                                                                         | SANDS WITH FINES<br>(Appreciable Amount of Fines)   |              | SM           | Silty Sand, Sand-Silt Mixtures                                                                                 |
|                                                                                                       |                                                                                                         |                                                     |              | SC           | Clayey Sand, Sand-Clay Mixtures                                                                                |
| <b>FINE GRAINED SOILS</b><br><br>More than 50% of Material is <b>SMALLER</b> than No. 200 Sieve Size  | <b>SILTS AND CLAYS</b><br><br>Liquid Limit <u>LESS</u> than 50%                                         |                                                     |              | ML           | Inorganic Silt and Very Fine Sand, Rock Flour, Silty or Clayey Fine Sand or Clayey Silt with Slight Plasticity |
|                                                                                                       |                                                                                                         |                                                     |              | CL           | Inorganic Clay of Low to Medium Plasticity, Gravely Clay, Sandy Clay, Silty Clay, Lean Clay                    |
|                                                                                                       |                                                                                                         |                                                     |              | OL           | Organic Silt and Organic Silty Clay of Low Plasticity                                                          |
|                                                                                                       | <b>SILTS AND CLAYS</b><br><br>Liquid Limit <u>GREATER</u> than 50%                                      |                                                     |              | MH           | Inorganic Silt, Micaceous or Diatomaceous Fine Sand or Silty Soil, Elastic Silt                                |
|                                                                                                       |                                                                                                         |                                                     |              | CH           | Inorganic Clay of High Plasticity, Fat Clay                                                                    |
|                                                                                                       |                                                                                                         |                                                     |              | OH           | Organic Clay of Medium to High Plasticity, Organic Silt                                                        |
| <b>HIGHLY ORGANIC SOILS</b>                                                                           |                                                                                                         |                                                     |              | PT           | Peat, Humus, Swamp Soils with High Organic Contents                                                            |

### SOIL CLASSIFICATION CHART

#### NOTES:

- 1) DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS.
- 2) IN THE CASE OF COMBINATIONS, THE PREDOMINANT MATERIAL WILL BE IN HEAVY SYMBOL.

## GEOTECHNICS

### Soil & Material Testing

□ 818 North 26th Street, Oakridge, IL Ph (617)923-9810 - Fax (617)229-9805  
 ■ 4610 Paine Road, Falmouth, ME Ph (617)229-9805 - Fax (617)229-9805  
 □ 810 N. Third Street, Suite 100, Burlington, VA Ph (617)753-1898 - Fax (617)753-9805  
 Internet Address: [www.kidman.com](http://www.kidman.com)

## UNIFIED SOIL CLASSIFICATION SYSTEM - ASTM D 2487 -

# **APPENDIX C**

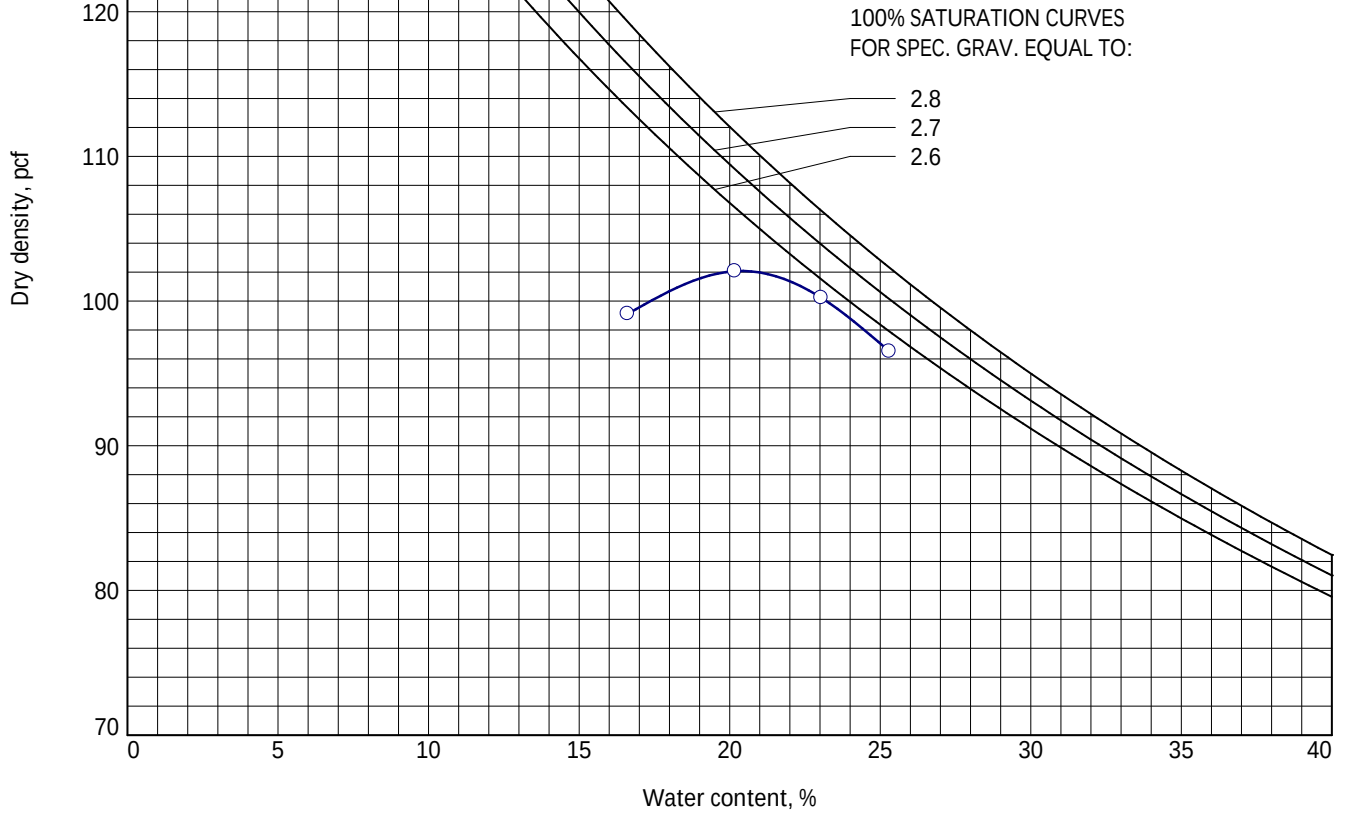
## **MOISTURE DENSITY RELATIONSHIP**



# COMPACTION TEST REPORT

DATE: 9/7/2022  
PROJECT NO.: 21-5052  
PROJECT: Hallsville Middle School Classroom

Test specification:  
ASTM D 698-12 Method A Standard



| No.    | LOCATION AND DESCRIPTION                                                                                                    |    |    |             |          |           |               | REMARKS                  |  |
|--------|-----------------------------------------------------------------------------------------------------------------------------|----|----|-------------|----------|-----------|---------------|--------------------------|--|
| ○ SP-1 | Loc.: Bulk 24, 25, 26, 27      Depth: 0-5 ft.      Sample No.: Bulk<br>Fat Clay (CH), Light Brown mottled Light Gray, Moist |    |    |             |          |           |               | Natural Moisture = 17.7% |  |
|        |                                                                                                                             |    |    |             |          |           |               |                          |  |
|        |                                                                                                                             |    |    |             |          |           |               |                          |  |
|        |                                                                                                                             |    |    |             |          |           |               |                          |  |
|        |                                                                                                                             |    |    |             |          |           |               |                          |  |
| No.    | USCS                                                                                                                        | LL | PI | NAT. MOIST. | OVERSIZE | %< No.200 | MAX. DRY DEN. | OPT. MOIST.              |  |
| ○ SP-1 | CH                                                                                                                          | 55 | 34 | 17.7        | %>#4=0.6 | 91.3 %    | 102.1         | 20.4 %                   |  |
|        |                                                                                                                             |    |    |             |          |           |               |                          |  |
|        |                                                                                                                             |    |    |             |          |           |               |                          |  |
|        |                                                                                                                             |    |    |             |          |           |               |                          |  |
|        |                                                                                                                             |    |    |             |          |           |               |                          |  |

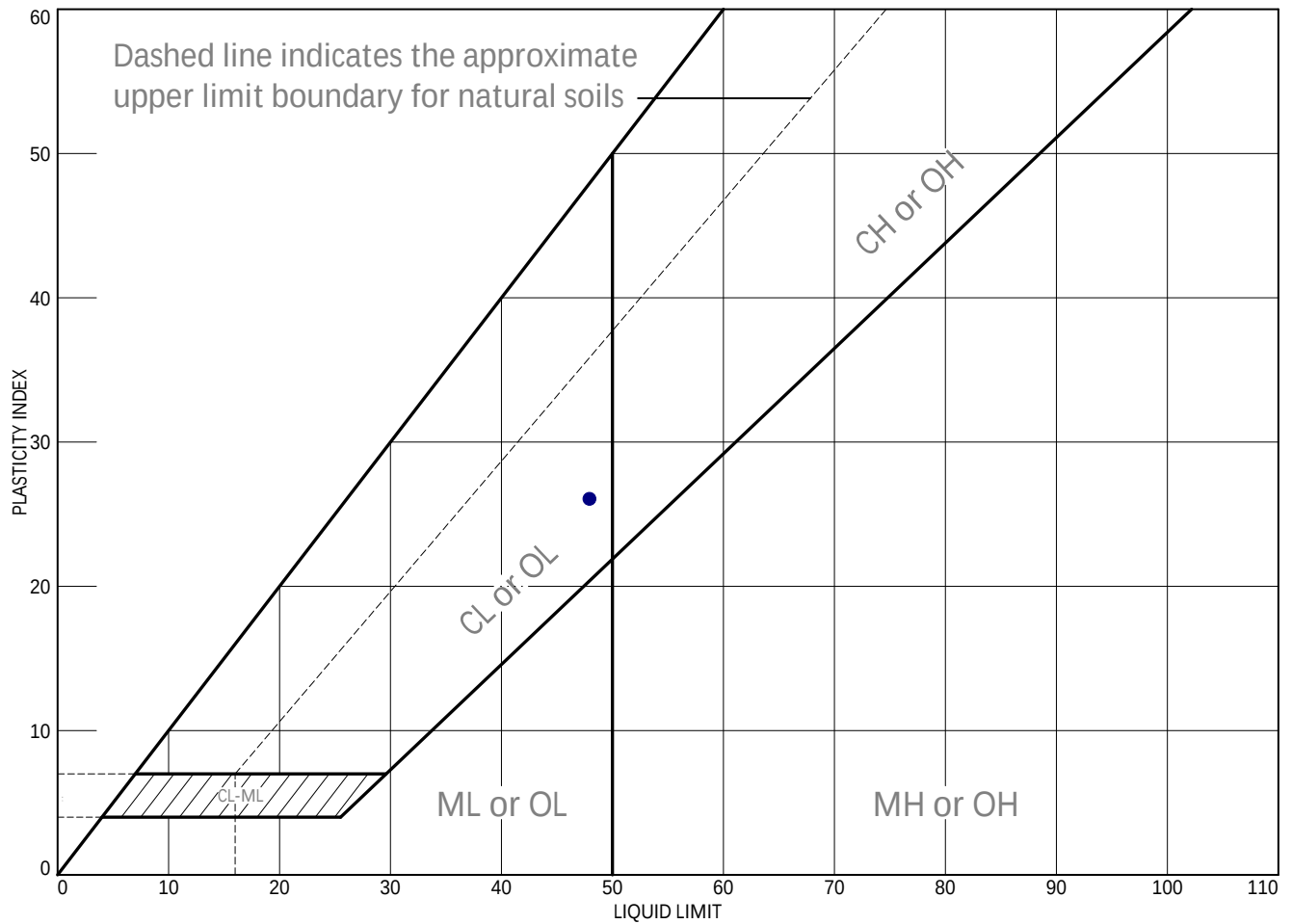
GEOTECHNICS

Figure SP-1

Tested By: DAW

**APPENDIX D**  
**ATTERBERG LIMIT**  
**DETERMINATIONS**

# LIQUID AND PLASTIC LIMITS TEST REPORT



|   | MATERIAL DESCRIPTION                                           | LL | PL | PI | %<#40 | %<#200 | USCS |
|---|----------------------------------------------------------------|----|----|----|-------|--------|------|
| ● | Lean Clay (CL), Light Brown mottled Yellow Brown, Silty, Moist | 48 | 22 | 26 |       |        | CL   |
|   |                                                                |    |    |    |       |        |      |
|   |                                                                |    |    |    |       |        |      |
|   |                                                                |    |    |    |       |        |      |
|   |                                                                |    |    |    |       |        |      |

Project No. 21-5052 Client: Hallsville R-IV School District

Project: Hallsville Middle School Classroom

● Location: Boring 6 Depth: 1-2½ ft. Sample Number: 0

Remarks:

● Natural Moisture = 10.9%

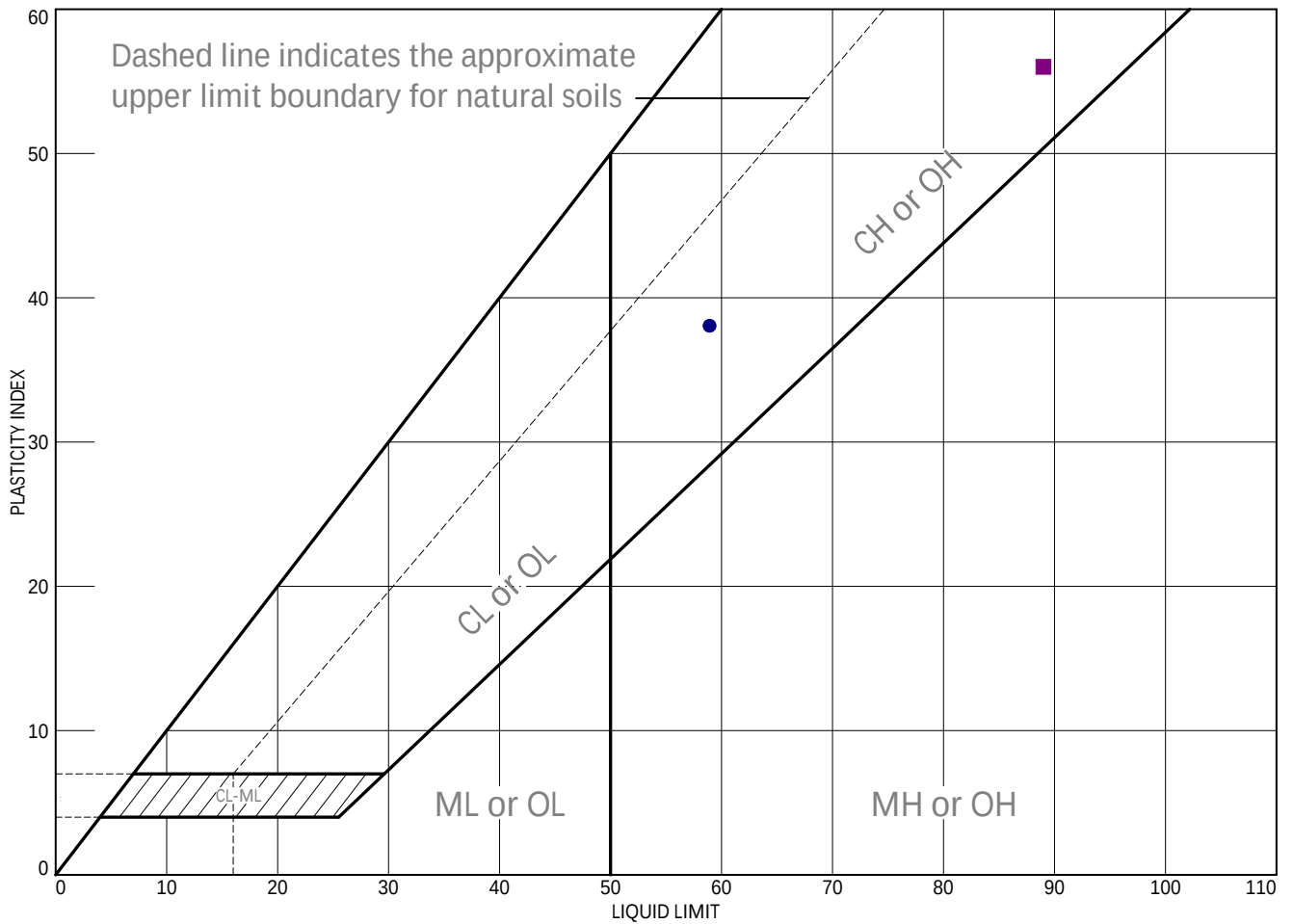
**GEOTECHNICS**  
Soil & Material Testing

4510 Paris Gravel Road - Hannibal, MO

Figure 1

Tested By: NPP

# LIQUID AND PLASTIC LIMITS TEST REPORT



|   | MATERIAL DESCRIPTION                                         | LL | PL | PI | %<#40 | %<#200 | USCS |
|---|--------------------------------------------------------------|----|----|----|-------|--------|------|
| ● | Fat Clay (CH), Brown mottled Light Brown, Silty, Moist       | 59 | 21 | 38 |       |        | CH   |
| ■ | Fat Clay (CH), Light Gray mottled Reddish Brown, Hard, Moist | 89 | 33 | 56 |       |        | CH   |
|   |                                                              |    |    |    |       |        |      |
|   |                                                              |    |    |    |       |        |      |

Project No. 21-5052 Client: Hallsville R-IV School District

Project: Hallsville Middle School Classroom

● Location: Boring 13 Depth: 1-2½ ft. Sample Number: 0

■ Location: Boring 18 Depth: 2½-4 ft. Sample Number: 1

Remarks:

● Natural Moisture = 23.6%

■ Natural Moisture = 21.9%

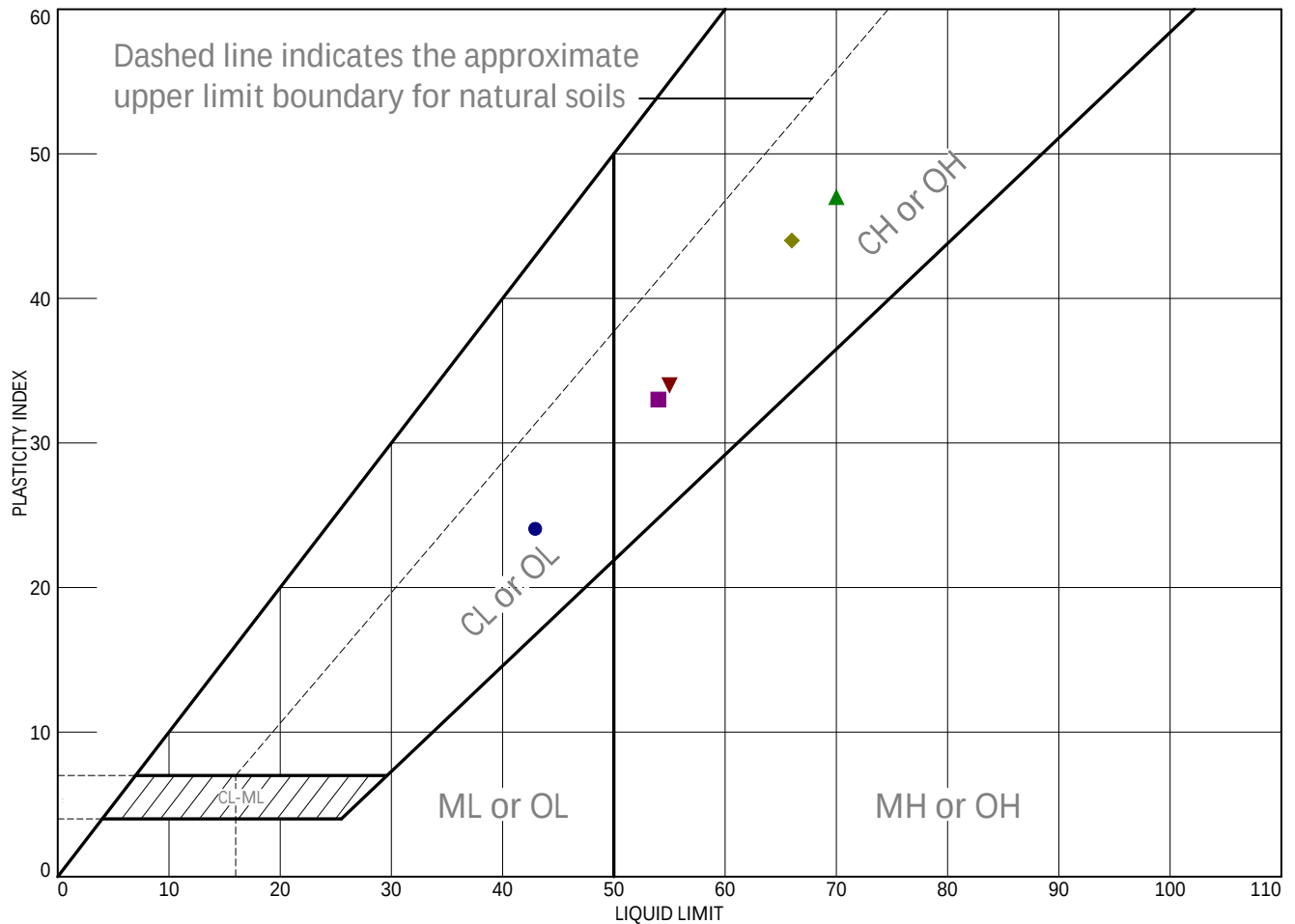
**GEOTECHNICS**  
Soil & Material Testing

4510 Paris Gravel Road - Hannibal, MO

Figure

Tested By: ○ NPP □ DAW

# LIQUID AND PLASTIC LIMITS TEST REPORT



| MATERIAL DESCRIPTION |                                                                                            | LL | PL | PI | %<#40 | %<#200 | USCS |
|----------------------|--------------------------------------------------------------------------------------------|----|----|----|-------|--------|------|
| ●                    | Lean Clay (CL), Light Gray mottled Yellow Brown, Black Oxidation, Trace Sand, Silty, Moist | 43 | 19 | 24 | 96.7  | 92.6   | CL   |
| ■                    | Fat Clay (CH), Light Gray mottled Yellow Brown, Silty, Trace Sand, Moist                   | 54 | 21 | 33 | 97.1  | 93.3   | CH   |
| ▲                    | Fat Clay (CH), Light Brown mottled Reddish Brown, Moist                                    | 70 | 23 | 47 | 99.7  | 99.4   | CH   |
| ◆                    | Fat Clay (CH), Light Gray mottled Light Brown, Moist                                       | 66 | 22 | 44 | 98.7  | 97.8   | CH   |
| ▼                    | Fat Clay (CH), Light Brown mottled Light Gray, Moist                                       | 55 | 21 | 34 | 96.3  | 91.3   | CH   |

|                                                                                        |                                         |                                                                                                                                                                       |
|----------------------------------------------------------------------------------------|-----------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Project No. 21-5052                                                                    | Client: Hallsville R-IV School District | <b>Remarks:</b><br>● Natural Moisture = 19.7%<br>■ Natural Moisture = 22.6%<br>▲ Natural Moisture = 23.2%<br>◆ Natural Moisture = 26.8%<br>▼ Natural Moisture = 17.7% |
| Project: Hallsville Middle School Classroom                                            |                                         |                                                                                                                                                                       |
| ● Location: Boring 24                                                                  | Depth: 6-48 in.                         | Sample Number: 2                                                                                                                                                      |
| ■ Location: Boring 24                                                                  | Depth: 48-58 in.                        | Sample Number: 3                                                                                                                                                      |
| ▲ Location: Boring 25                                                                  | Depth: 12-22 in.                        | Sample Number: 2                                                                                                                                                      |
| ◆ Location: Boring 26                                                                  | Depth: 23-34 in.                        | Sample Number: 2                                                                                                                                                      |
| ▼ Location: Bulk 24, 25, 26, 27                                                        | Depth: 0-5 ft.                          | Sample Number: Bulk                                                                                                                                                   |
| <b>GEOTECHNICS</b><br>Soil & Material Testing<br>4510 Paris Gravel Road - Hannibal, MO |                                         |                                                                                                                                                                       |

Figure 2

Tested By: ○ NPP   ■ DAW   ▲ BRH   ◆ BRH   ▼ DJS

# **APPENDIX E**

## **GRADATION ANALYSIS RESULTS**

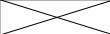
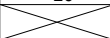


PERCENT FINER

GRAIN SIZE - mm.

| Grain Size (mm) | Sieve / Note | Percent Finer (%) |
|-----------------|--------------|-------------------|
| 6.0             | 6 in.        | 100               |
| 3.0             | 3 in.        | 100               |
| 2.0             | 2 in.        | 100               |
| 1.5             | 1½ in.       | 100               |
| 1.0             | 1 in.        | 100               |
| 0.75            | ¾ in.        | 100               |
| 0.5             | ½ in.        | 100               |
| 0.375           | 3/8 in.      | 100               |
| 0.25            | No. 60       | 100               |
| 0.2             | No. 75       | 100               |
| 0.15            | No. 100      | 100               |
| 0.125           | No. 120      | 100               |
| 0.106           | No. 140      | 100               |
| 0.075           | No. 20       | 93                |
| 0.06            | No. 25       | 93                |
| 0.05            | No. 30       | 93                |
| 0.0425          | No. 40       | 93                |
| 0.0355          | No. 48       | 93                |
| 0.03            | No. 60       | 93                |
| 0.025           | No. 60       | 93                |
| 0.02            | No. 75       | 93                |
| 0.015           | No. 100      | 93                |
| 0.0125          | No. 120      | 93                |
| 0.0106          | No. 140      | 93                |
| 0.0085          | No. 200      | 93                |

|   | +3" | % GRAVEL | % SAND | % SILT | % CLAY | USCS | LL | PL | PI |
|---|-----|----------|--------|--------|--------|------|----|----|----|
| ○ | 0.0 | 0.0      | 7.4    | 92.6   |        | CL   | 43 | 19 | 24 |
| □ | 0.0 | 0.0      | 6.7    | 93.3   |        | CH   | 54 | 21 | 33 |
| △ | 0.0 | 0.0      | 0.6    | 99.4   |        | CH   | 70 | 23 | 47 |

| SIEVE<br>inches<br>size                                                             | PERCENT FINER                                                                       |                                                                                     |                                                                                     |
|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
|                                                                                     |  |  |  |
|                                                                                     |                                                                                     |                                                                                     |                                                                                     |
|  | GRAIN SIZE                                                                          |                                                                                     |                                                                                     |
| D <sub>60</sub>                                                                     |                                                                                     |                                                                                     |                                                                                     |
| D <sub>30</sub>                                                                     |                                                                                     |                                                                                     |                                                                                     |
| D <sub>10</sub>                                                                     |                                                                                     |                                                                                     |                                                                                     |
|  | COEFFICIENTS                                                                        |                                                                                     |                                                                                     |
| C <sub>c</sub>                                                                      |                                                                                     |                                                                                     |                                                                                     |
| C <sub>u</sub>                                                                      |                                                                                     |                                                                                     |                                                                                     |

| SIEVE<br>number<br>size | PERCENT FINER |       |       |
|-------------------------|---------------|-------|-------|
|                         | ○             | □     | △     |
| #4                      | 100.0         | 100.0 | 100.0 |
| #10                     | 99.3          | 99.6  | 100.0 |
| #40                     | 96.7          | 97.1  | 99.7  |
| #200                    | 92.6          | 93.3  | 99.4  |

- Lean Clay (CL), Light Gray mottled Yellow Brown, Black Oxidation, Trace Sand, Silty, Moist
- Fat Clay (CH), Light Gray mottled Yellow Brown, Silty, Trace Sand, Moist
- △ Fat Clay (CH), Light Brown mottled Reddish Brown, Moist

- Natural Moisture = 19.7%
- Natural Moisture = 22.6%
- △ Natural Moisture = 23.2%

|                       |                  |
|-----------------------|------------------|
| ○ Location: Boring 24 | Depth: 6-48 in.  |
| □ Location: Boring 24 | Depth: 48-58 in. |
| △ Location: Boring 25 | Depth: 12-22 in. |

Sample Number: 2  
Sample Number: 3  
Sample Number: 2

4510 Paris Gravel Road - Hannibal, MO

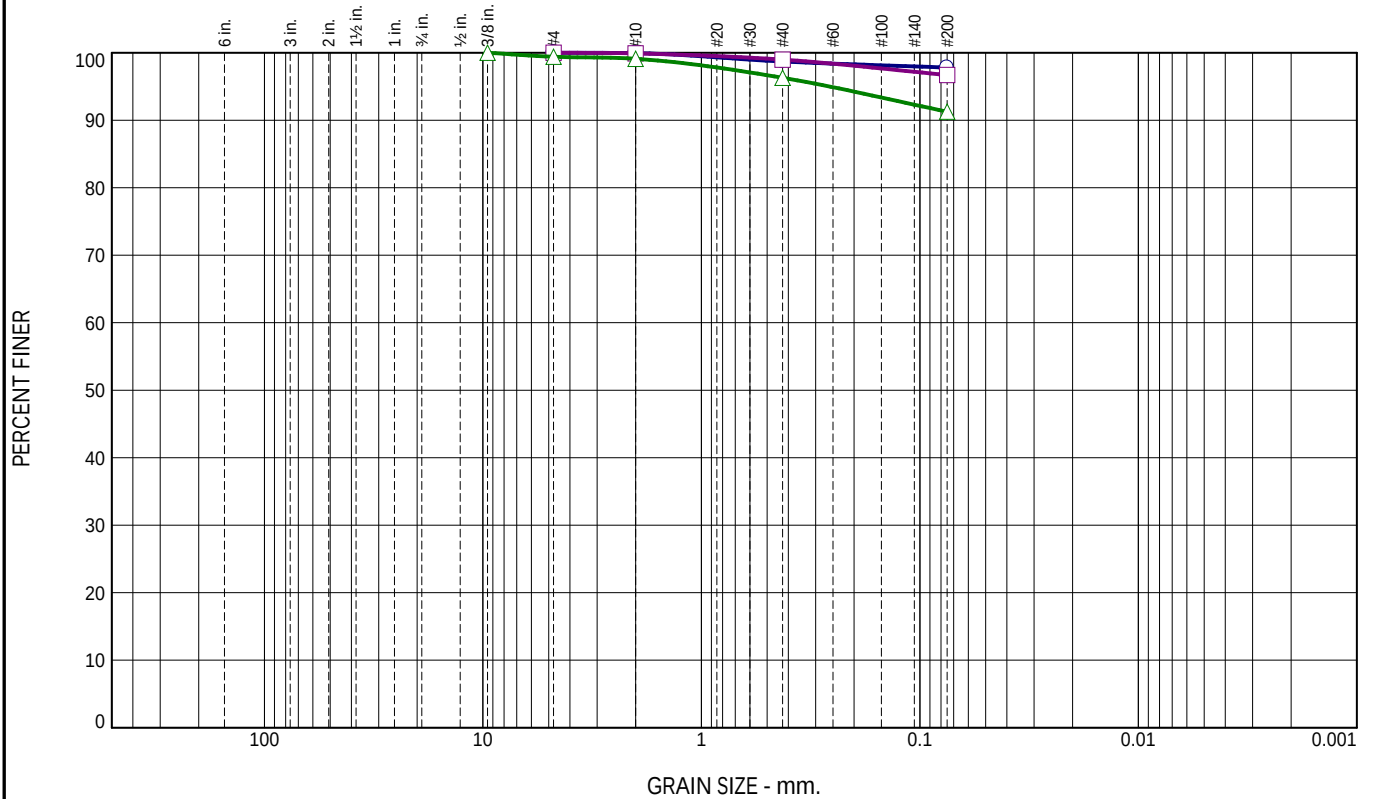
|          |                                    |
|----------|------------------------------------|
| Client:  | Hallsville R-IV School District    |
| Project: | Hallsville Middle School Classroom |

Project No.: 21-5052

Figure 1

Tested By: DAW

# Particle Size Distribution Report



|   | +3" | % GRAVEL | % SAND | % SILT | % CLAY | USCS | LL | PL | PI |
|---|-----|----------|--------|--------|--------|------|----|----|----|
| ○ | 0.0 | 0.0      | 2.2    | 97.8   |        | CH   | 66 | 22 | 44 |
| □ | 0.0 | 0.0      | 3.3    | 96.7   |        | (CH) |    |    |    |
| △ | 0.0 | 0.6      | 8.1    | 91.3   |        | CH   | 55 | 21 | 34 |

| SIEVE<br>inches<br>size | PERCENT FINER |   |       |
|-------------------------|---------------|---|-------|
|                         | ○             | □ | △     |
| 3/8"                    |               |   | 100.0 |
| GRAIN SIZE              |               |   |       |
| D <sub>60</sub>         |               |   |       |
| D <sub>30</sub>         |               |   |       |
| D <sub>10</sub>         |               |   |       |
| COEFFICIENTS            |               |   |       |
| C <sub>c</sub>          |               |   |       |
| C <sub>u</sub>          |               |   |       |

| SIEVE<br>number<br>size | PERCENT FINER |       |      |
|-------------------------|---------------|-------|------|
|                         | ○             | □     | △    |
| #4                      | 100.0         | 100.0 | 99.4 |
| #10                     | 99.9          | 99.9  | 99.1 |
| #40                     | 98.7          | 99.0  | 96.3 |
| #200                    | 97.8          | 96.7  | 91.3 |

| Material Description                                   |
|--------------------------------------------------------|
| ○ Fat Clay (CH), Light Gray mottled Light Brown, Moist |
| □ Fat Clay (CH), Light Gray mottled Yellow Brown, Wet  |
| △ Fat Clay (CH), Light Brown mottled Light Gray, Moist |

| REMARKS:                   |
|----------------------------|
| ○ Natural Moisture = 26.8% |
| □ Natural Moisture = 35.0% |
| △ Natural Moisture = 17.7% |

○ Location: Boring 26      Depth: 23-34 in.      Sample Number: 2  
 □ Location: Boring 27      Depth: 47-57 in.      Sample Number: 4  
 △ Location: Bulk 24, 25, 26, 27      Depth: 0-5 ft.      Sample Number: Bulk

|                                                                                                   |                                             |
|---------------------------------------------------------------------------------------------------|---------------------------------------------|
| <b>GEOTECHNICS</b><br><b>Soil &amp; Material Testing</b><br>4510 Paris Gravel Road - Hannibal, MO | Client: Hallsville R-IV School District     |
|                                                                                                   | Project: Hallsville Middle School Classroom |
| Project No.: 21-5052                                                                              | Figure 2                                    |

Tested By: DAW

**APPENDIX F**  
**BORING LOGS-MIDDLE SCHOOL**  
**CLASSROOM**

Project No.: 21-5052

Project: Hallsville Middle School Classroom  
Athletic Track/Field and Improvements

Client: Hallsville R-IV School District

Boring No.: B1

**Boring Log**

Rig: CME 55 (B-55)

Location: Hallsville, MO

Driller: AJK

| SUBSURFACE PROFILE |        |                                                                                                                   |            |                        |                                | SAMPLE |      |           |            | Standard Penetration<br>Test<br>blows/ft. | Water Content %<br><br>Wp ——— WI |
|--------------------|--------|-------------------------------------------------------------------------------------------------------------------|------------|------------------------|--------------------------------|--------|------|-----------|------------|-------------------------------------------|----------------------------------|
| Depth (ft.)        | Symbol | Description                                                                                                       | Qp, t.s.f. | Dry Density,<br>P.C.F. | Depth/Elev.                    | Number | Type | Blows/ft. | Qu, T.S.F. |                                           |                                  |
| 0                  |        | Ground Surface                                                                                                    |            |                        | 898.9                          |        |      |           |            | 10 20 30 40                               | 10 20 30 40                      |
|                    |        | Topsoil (5")                                                                                                      |            |                        |                                |        |      |           |            |                                           |                                  |
|                    |        | Fill: Lean Clay (CL), Light Brown, Trace Crushed Stone, Moist                                                     |            |                        |                                | 0      | HA   |           |            |                                           | 15.1                             |
|                    |        | Fill: (CL), Light Brown/Yellow Brown mottled Light Gray, Silty, Soft, Moist                                       |            |                        |                                | 1      | SS   | 3         |            |                                           | 28.1                             |
| 5                  |        | Fill: (CL), Gray mottled Light Brown/Brown, Trace Crushed Stone, Soft, Moist                                      |            |                        |                                | 2      | SS   | 2         |            |                                           | 28.1                             |
|                    |        |                                                                                                                   |            |                        | 891.4                          |        |      |           |            |                                           |                                  |
|                    |        | Fat Clay (CH), Light Gray mottled Yellow Brown, Reddish Brown Oxidation, Stiff, Moist                             | 1.50       | 101.1                  | 7.5                            | 3      | SS   | 7         | 1.92       |                                           | 23.3                             |
| 10                 |        | (CH), Stiff, Moist                                                                                                | 2.00       |                        |                                | 4      | SS   | 9         |            |                                           | 23.4                             |
|                    |        | (CH), Very Stiff, Moist                                                                                           | 2.00       | 104.1                  |                                | 5      | ST   |           | 2.71       |                                           | 21.7                             |
| 15                 |        | (CH), Stiff, Moist                                                                                                | 2.25       |                        |                                | 6      | SS   | 11        |            |                                           | 21.4                             |
| 20                 |        | (CH), Trace Sand, Stiff, Moist                                                                                    | 0.50       |                        |                                | 7      | SS   | 10        |            |                                           | 20.7                             |
| 25                 |        | Sandy Lean Clay (CL/CH), Yellow Brown mottled Light Gray, Black Oxidation, Silty, Trace Gravel, Very Stiff, Moist | 3.00       |                        | 873.9<br>25.0<br>872.4<br>26.5 | 8      | SS   | 15        |            |                                           | 15.7                             |
|                    |        | End of Boring @ 26½ Ft.                                                                                           |            |                        |                                |        |      |           |            |                                           |                                  |
| 30                 |        |                                                                                                                   |            |                        |                                |        |      |           |            |                                           |                                  |

Drill Method: 3 1/4" HSA with AW Rod

Boring Started: 7/21/2022

Boring Completed: 7/21/2022

Tested By: AJK/BRH/DJS/DAW/NPP

Logging By: BRH

**GEOTECHNICS**  
 Soil & Material Testing

Groundwater Elev. During Drilling: ▽

Groundwater Elev. @ Comp.: ▽

Groundwater Elev. @ 24 Hrs.: ▽

Boring Location: See Location Sketch

Sheet 1 of 1

Project No.: 21-5052

Project: Hallsville Middle School Classroom  
Athletic Track/Field and Improvements

Client: Hallsville R-IV School District

Boring No.: B2

**Boring Log**

Rig: CME 55 (B-55)

Location: Hallsville, MO

Driller: AJK

| SUBSURFACE PROFILE |        |                                                                                                    |            |                        |             | SAMPLE |      |           |            | Standard Penetration<br>Test<br>blows/ft. | Water Content %<br><br>Wp ——— WI |
|--------------------|--------|----------------------------------------------------------------------------------------------------|------------|------------------------|-------------|--------|------|-----------|------------|-------------------------------------------|----------------------------------|
| Depth (ft.)        | Symbol | Description                                                                                        | Qp, t.s.f. | Dry Density,<br>P.C.F. | Depth/Elev. | Number | Type | Blows/ft. | Qu, T.S.F. |                                           |                                  |
| 0                  |        | Ground Surface                                                                                     |            |                        | 898.5       |        |      |           |            | 10 20 30 40                               | 10 20 30 40                      |
|                    |        | Topsoil (3")                                                                                       |            |                        |             |        |      |           |            |                                           |                                  |
|                    |        | Fill: Crushed Lime Fines (SM), Light Brown, Moist                                                  |            |                        |             | 0      | HA   |           |            |                                           | 4.3                              |
|                    |        | Fill: (SM), Light Gray, Medium Dense, Moist                                                        |            |                        |             | 1      | SS   | 17        |            |                                           | 5.1                              |
|                    |        |                                                                                                    |            |                        | 894.5       |        |      |           |            |                                           |                                  |
|                    |        | Light Gravel (4½ to 5 ft.)                                                                         |            |                        | 4.0         |        |      |           |            |                                           |                                  |
| 5                  |        | Fill: Lean Clay (CL), Gray mottled Brown/Light Brown, Trace Crushed Stone and Brick, Medium, Moist | 0.75       | 101.1                  | 892.5       | 2      | SS   | 5         | 1.67       |                                           | 24.4                             |
|                    |        |                                                                                                    |            |                        | 6.0         |        |      |           |            |                                           |                                  |
|                    |        | Fat Clay (CH), Light Gray mottled Yellow Brown, Medium, Moist                                      | 1.25       |                        |             | 3      | SS   | 8         |            |                                           | 24.7                             |
|                    |        |                                                                                                    |            |                        |             |        |      |           |            |                                           |                                  |
| 10                 |        | (CH), Very Stiff, Moist                                                                            | 2.25       | 105.2                  |             | 4      | ST   |           | 2.81       |                                           | 22.2                             |
|                    |        |                                                                                                    |            |                        |             |        |      |           |            |                                           |                                  |
|                    |        | (CH), Black Oxidation, Stiff, Moist                                                                | 2.00       |                        |             | 5      | SS   | 13        |            |                                           | 20.1                             |
|                    |        |                                                                                                    |            |                        |             |        |      |           |            |                                           |                                  |
| 15                 |        | (CH), Black Oxidation, Stiff, Moist                                                                | 1.75       |                        |             | 6      | SS   | 10        |            |                                           | 24.3                             |
|                    |        |                                                                                                    |            |                        | 882.0       |        |      |           |            |                                           |                                  |
|                    |        |                                                                                                    |            |                        | 16.5        |        |      |           |            |                                           |                                  |
|                    |        | End of Boring @ 16½ Ft.                                                                            |            |                        |             |        |      |           |            |                                           |                                  |
| 20                 |        |                                                                                                    |            |                        |             |        |      |           |            |                                           |                                  |
|                    |        |                                                                                                    |            |                        |             |        |      |           |            |                                           |                                  |
| 25                 |        |                                                                                                    |            |                        |             |        |      |           |            |                                           |                                  |
|                    |        |                                                                                                    |            |                        |             |        |      |           |            |                                           |                                  |
| 30                 |        |                                                                                                    |            |                        |             |        |      |           |            |                                           |                                  |

Drill Method: 3 1/4" HSA with AW Rod

Boring Started: 7/21/2022

Boring Completed: 7/21/2022

Tested By: AJK/BRH/DJS/DAW/NPP

Logging By: BRH

**GEOTECHNICS**  
 Soil & Material Testing

Groundwater Elev. During Drilling: ▽

Groundwater Elev. @ Comp.: ▽

Groundwater Elev. @ 24 Hrs.: ▽

Boring Location: See Location Sketch

Sheet 1 of 1

Project No.: 21-5052

Project: Hallsville Middle School Classroom  
Athletic Track/Field and Improvements

Client: Hallsville R-IV School District

Boring No.: B3

## Boring Log

Rig: CME 55 (B-55)

Location: Hallsville, MO

Driller: AJK

| SUBSURFACE PROFILE |        |                                                                               |            |                        |             | SAMPLE |      |           |            | Standard Penetration<br>Test<br>blows/ft. | Water Content %<br><br>Wp ——— WI |
|--------------------|--------|-------------------------------------------------------------------------------|------------|------------------------|-------------|--------|------|-----------|------------|-------------------------------------------|----------------------------------|
| Depth (ft.)        | Symbol | Description                                                                   | Qp, t.s.f. | Dry Density,<br>P.C.F. | Depth/Elev. | Number | Type | Blows/ft. | Qu, T.S.F. |                                           |                                  |
| 0                  |        | Ground Surface                                                                |            |                        | 899.1       |        |      |           |            | 10 20 30 40                               | 10 20 30 40                      |
|                    |        | Topsoil (6")                                                                  |            |                        | 898.6       |        |      |           |            |                                           |                                  |
|                    |        | Fill: Lean Clay (CL), Light Brown, Trace Brick, Moist                         |            |                        | 0.5         | 0      | HA   |           |            |                                           | 15.6                             |
|                    |        | Fill: Fat Clay (CH), Gray/Light Gray mottled Light Brown, Soft, Moist         |            |                        | 896.6       | 1      | SS   | 4         |            |                                           | 15.4                             |
|                    |        | Light To Medium Gravel (3 to 4½ ft.)                                          |            |                        | 894.1       |        |      |           |            |                                           |                                  |
| 5                  |        | Lean Clay (CL), Yellow Brown mottled Light Brown, Silty, Stiff, Moist         | 1.00       | 96.7                   | 5.0         | 2      | ST   |           | 1.29       |                                           | 24.4                             |
|                    |        | Fat Clay (CH), Light Gray mottled Yellow Brown, Black Oxidation, Stiff, Moist | 1.25       | 101.9                  | 7.5         | 3      | SS   | 7         | 1.48       |                                           | 23.2                             |
| 10                 |        | (CH), Stiff, Moist                                                            | 1.50       |                        |             | 4      | SS   | 9         |            |                                           | 22.9                             |
|                    |        | (CH), Light Gray, Stiff, Moist                                                | 1.75       |                        |             | 5      | SS   | 9         |            |                                           | 21.6                             |
| 15                 |        | (CH), Stiff, Moist                                                            | 2.00       |                        |             | 6      | SS   | 8         |            |                                           | 23.3                             |
| 20                 |        | (CH), Mottled Yellow Brown/Light Brown, Trace Sand, Stiff, Moist              | 2.00       |                        |             | 7      | SS   | 10        |            |                                           | 20.2                             |
|                    |        | End of Boring @ 21½ Ft.                                                       |            |                        | 877.6       |        |      |           |            |                                           |                                  |
|                    |        |                                                                               |            |                        | 21.5        |        |      |           |            |                                           |                                  |
| 25                 |        |                                                                               |            |                        |             |        |      |           |            |                                           |                                  |
| 30                 |        |                                                                               |            |                        |             |        |      |           |            |                                           |                                  |

Drill Method: 3 1/4" HSA with AW Rod

Boring Started: 7/21/2022

Boring Completed: 7/21/2022

Tested By: AJK/BRH/DJS/DAW/NPP

Logging By: BRH

**GEOTECHNICS**  
 Soil & Material Testing

Groundwater Elev. During Drilling: ▽

Groundwater Elev. @ Comp.: ▽

Groundwater Elev. @ Hrs.: ▽

Boring Location: See Location Sketch

Sheet 1 of 1

Project No.: 21-5052

Project: Hallsville Middle School Classroom  
Athletic Track/Field and Improvements

Client: Hallsville R-IV School District

Boring No.: B4

## Boring Log

Rig: CME 55 (B-55)

Location: Hallsville, MO

Driller: AJK

| SUBSURFACE PROFILE |        |                                                                      |            |                        |             | SAMPLE |      |           |            | Standard Penetration<br>Test<br>blows/ft. | Water Content %<br><br>Wp ——— WI |
|--------------------|--------|----------------------------------------------------------------------|------------|------------------------|-------------|--------|------|-----------|------------|-------------------------------------------|----------------------------------|
| Depth (ft.)        | Symbol | Description                                                          | Qp, t.s.f. | Dry Density,<br>P.C.F. | Depth/Elev. | Number | Type | Blows/ft. | Qu, T.S.F. |                                           |                                  |
| 0                  |        | Ground Surface                                                       |            |                        | 898.4       |        |      |           |            | 10 20 30 40                               | 10 20 30 40                      |
|                    |        | Topsoil (5")                                                         |            |                        |             |        |      |           |            |                                           |                                  |
|                    |        | Fill: Lean Clay (CL), Light Brown, Trace Crushed Stone, Moist        |            |                        | 895.9       | 0      | HA   |           |            |                                           | 13.6                             |
|                    |        | Fat Clay (CH), Light Brown mottled Yellow Brown, Stiff, Moist        | 2.00       | 93.5                   | 2.5         | 1      | SS   | 7         | 1.94       |                                           | 28.1                             |
| 5                  |        | Fat Clay (CH), Light Gray mottled Yellow Brown, Silty, Medium, Moist | 1.50       | 96.2                   |             | 2      | ST   |           | 0.97       |                                           | 23.3                             |
|                    |        | (CH), Black Oxidation, Stiff, Moist                                  | 0.75       |                        |             | 3      | SS   | 7         |            |                                           | 24.0                             |
| 10                 |        | (CH), Mottled Yellow Brown/Reddish Brown, Medium, Moist              | 1.50       |                        |             | 4      | SS   | 7         |            |                                           | 25.4                             |
|                    |        | (CH), Stiff, Moist                                                   | 1.75       |                        |             | 5      | SS   | 12        |            |                                           | 20.1                             |
| 15                 |        | (CH), Stiff, Moist                                                   | 2.25       |                        |             | 6      | SS   | 11        |            |                                           | 18.0                             |
| 20                 |        | (CH), Light Gray mottled Yellow Brown, Trace Sand, Very Stiff, Moist | 2.75       |                        | 876.9       | 7      | SS   | 16        |            |                                           | 21.7                             |
|                    |        | End of Boring @ 21½ Ft.                                              |            |                        | 21.5        |        |      |           |            |                                           |                                  |
| 25                 |        |                                                                      |            |                        |             |        |      |           |            |                                           |                                  |
| 30                 |        |                                                                      |            |                        |             |        |      |           |            |                                           |                                  |

Drill Method: 3 1/4" HSA with AW Rod

Boring Started: 7/22/2022

Boring Completed: 7/22/2022

Tested By: AJK/BRH/DJS/DAW/NPP

Logging By: BRH

**GEOTECHNICS**  
 Soil & Material Testing

Groundwater Elev. During Drilling: ▽

Groundwater Elev. @ Comp.: ▽

Groundwater Elev. @ 3.25Hrs.: ▽

Boring Location: See Location Sketch

Sheet 1 of 1



Project No.: 21-5052

Project: Hallsville Middle School Classroom  
Athletic Track/Field and Improvements

Client: Hallsville R-IV School District

Boring No.: B5

## Boring Log

Rig: CME 55 (B-55)

Location: Hallsville, MO

Driller: AJK

| SUBSURFACE PROFILE |        |                                                                                                |            |                        |               | SAMPLE |      |           |            | Standard Penetration<br>Test<br>blows/ft. | Water Content %<br><br>Wp ——— WI |
|--------------------|--------|------------------------------------------------------------------------------------------------|------------|------------------------|---------------|--------|------|-----------|------------|-------------------------------------------|----------------------------------|
| Depth (ft.)        | Symbol | Description                                                                                    | Qp, t.s.f. | Dry Density,<br>P.C.F. | Depth/Elev.   | Number | Type | Blows/ft. | Qu, T.S.F. |                                           |                                  |
| 0                  |        | Ground Surface                                                                                 |            |                        | 898.2         |        |      |           |            | 10 20 30 40                               | 10 20 30 40                      |
|                    |        | Topsoil (5")                                                                                   |            |                        |               |        |      |           |            |                                           |                                  |
|                    |        | Fill: Lean Clay (CL), Light Brown/ Yellow Brown mottled Light Gray, Trace Crushed Stone, Moist |            |                        |               | 0      | HA   |           |            |                                           | 19.3                             |
|                    |        | Fill: (CL), Light Gray mottled Reddish Brown/Light Brown/Brown, Stiff, Moist                   | 3.50       |                        |               | 1      | SS   | 12        |            |                                           | 21.9                             |
| 5                  |        | Lean Clay (CL), Light Gray mottled Yellow Brown, Silty, Medium, Moist                          | 0.75       | 96.6                   | 893.2<br>5.0  | 2      | SS   | 8         | 0.99       |                                           | 24.9                             |
|                    |        | Fat Clay (CH), Light Gray mottled Yellow Brown, Reddish Brown Oxidation, Stiff, Moist          | 1.50       |                        | 890.7<br>7.5  | 3      | SS   | 9         |            |                                           | 24.5                             |
| 10                 |        | (CH), Stiff, Moist                                                                             | 0.75       | 102.8                  |               | 4      | ST   |           | 1.23       |                                           | 21.9                             |
|                    |        | (CH), Stiff, Moist                                                                             | 2.00       |                        |               | 5      | SS   | 11        |            |                                           | 21.3                             |
| 15                 |        | (CH), Light Gray, Stiff, Moist                                                                 | 2.25       |                        |               | 6      | SS   | 11        |            |                                           | 22.3                             |
|                    |        | End of Boring @ 16½ Ft.                                                                        |            |                        | 881.7<br>16.5 |        |      |           |            |                                           |                                  |
| 20                 |        |                                                                                                |            |                        |               |        |      |           |            |                                           |                                  |
| 25                 |        |                                                                                                |            |                        |               |        |      |           |            |                                           |                                  |
| 30                 |        |                                                                                                |            |                        |               |        |      |           |            |                                           |                                  |

Drill Method: 3 1/4" HSA with AW Rod

Boring Started: 7/22/2022

Boring Completed: 7/22/2022

Tested By: AJK/BRH/DJS/DAW/NPP

Logging By: BRH

**GEOTECHNICS**  
 Soil & Material Testing

Groundwater Elev. During Drilling: ▽

Groundwater Elev. @ Comp.: ▽

Groundwater Elev. @ 2.25Hrs.: ▽

Boring Location: See Location Sketch

Sheet 1 of 1

Project No.: 21-5052

Project: Hallsville Middle School Classroom  
Athletic Track/Field and Improvements

Client: Hallsville R-IV School District

Boring No.: B6

## Boring Log

Rig: CME 55 (B-55)

Location: Hallsville, MO

Driller: AJK

| SUBSURFACE PROFILE |        |                                                                                   |            |                        |             | SAMPLE |      |           |            | Standard Penetration<br>Test<br>blows/ft. | Water Content %<br><br>Wp ———— WI |
|--------------------|--------|-----------------------------------------------------------------------------------|------------|------------------------|-------------|--------|------|-----------|------------|-------------------------------------------|-----------------------------------|
| Depth (ft.)        | Symbol | Description                                                                       | Qp, t.s.f. | Dry Density,<br>P.C.F. | Depth/Elev. | Number | Type | Blows/ft. | Qu, T.S.F. |                                           |                                   |
| 0                  |        | Ground Surface                                                                    |            |                        | 898.6       |        |      |           |            | 10 20 30 40                               | 10 20 30 40                       |
|                    |        | Topsoil (6")                                                                      |            |                        | 898.1       |        |      |           |            |                                           |                                   |
|                    |        | Lean Clay (CL), Light Brown mottled Yellow Brown, Silty, Moist                    |            |                        | 0.5         | 0      | HA   |           |            |                                           | 10.9                              |
|                    |        | (CL), Light Brown, Silty, With Fat Clay Seams, Medium, Moist                      | 1.25       |                        |             | 1      | SS   | 7         |            |                                           | 26.7                              |
| 5                  |        | (CL), Light Gray mottled Yellow Brown, Silty, Stiff, Moist                        | 0.75       | 96.2                   |             | 2      | SS   | 7         | 1.02       |                                           | 28.0                              |
|                    |        | Fat Clay (CH), Light Gray mottled Yellow Brown, Very Stiff, Moist                 |            | 104.2                  | 891.1       | 3      | ST   |           | 2.16       |                                           | 20.7                              |
| 10                 |        | (CH), Stiff, Moist                                                                | 2.00       |                        | 7.5         | 4      | SS   | 7         |            |                                           | 24.9                              |
|                    |        | (CH), Trace Sand, Very Stiff, Moist                                               | 2.50       |                        |             | 5      | SS   | 15        |            |                                           | 19.5                              |
| 15                 |        | (CH), Black Oxidation, Trace Sand, Stiff, Moist                                   | 1.75       |                        |             | 6      | SS   | 10        |            |                                           | 22.8                              |
| 20                 |        | Lean Clay (CL/CH), Yellow Brown mottled Light Gray, Trace Sand, Very Stiff, Moist | 3.25       |                        | 878.6       | 7      | SS   | 15        |            |                                           | 18.1                              |
| 25                 |        | (CL/CH), Trace Sand, Stiff, Moist                                                 | 2.75       |                        | 872.1       | 8      | SS   | 14        |            |                                           | 15.7                              |
|                    |        | End of Boring @ 26½ Ft.                                                           |            |                        | 26.5        |        |      |           |            |                                           |                                   |
| 30                 |        |                                                                                   |            |                        |             |        |      |           |            |                                           |                                   |

Drill Method: 3 1/4" HSA with AW Rod

Boring Started: 7/21/2022

Boring Completed: 7/21/2022

Tested By: AJK/BRH/DJS/DAW/NPP

Logging By: BRH

**GEOTECHNICS**  
 Soil & Material Testing

Groundwater Elev. During Drilling: ▽

Groundwater Elev. @ Comp.: ▽

Groundwater Elev. @ Hrs.: ▽

Boring Location: See Location Sketch

Sheet 1 of 1

Project No.: 21-5052

Project: Hallsville Middle School Classroom  
Athletic Track/Field and Improvements

Client: Hallsville R-IV School District

Boring No.: B28

## Boring Log

Rig: CME 55 (B-55)

Location: Hallsville, MO

Driller: AJK

| SUBSURFACE PROFILE |        |                                                                                     |            |                        |             | SAMPLE |      |           |            | Standard Penetration<br>Test<br>blows/ft. | Water Content %<br><br>Wp ——— WI |
|--------------------|--------|-------------------------------------------------------------------------------------|------------|------------------------|-------------|--------|------|-----------|------------|-------------------------------------------|----------------------------------|
| Depth (ft.)        | Symbol | Description                                                                         | Qp, t.s.f. | Dry Density,<br>P.C.F. | Depth/Elev. | Number | Type | Blows/ft. | Qu, T.S.F. |                                           |                                  |
| 0                  |        | Ground Surface                                                                      |            |                        | 899.0       |        |      |           |            | 10 20 30 40                               | 10 20 30 40                      |
|                    |        | Topsoil (6")                                                                        |            |                        | 898.5       |        |      |           |            |                                           |                                  |
|                    |        | Fill: Lean Clay (CL), Light Brown, Trace Crushed Stone, Moist                       |            |                        | 0.5         | 0      | HA   |           |            |                                           | 10.8                             |
|                    |        | Fill: (CL), Light Gray mottled Yellow Brown, Silty, Stiff, Moist                    | 1.00       |                        |             | 1      | SS   | 9         |            |                                           | 25.7                             |
| 5                  |        | Lean Clay (CL), Light Gray mottled Yellow Brown/Reddish Brown, Silty, Medium, Moist | 0.25       | 94.6                   | 894.0       | 2      | SS   | 6         | 0.95       |                                           | 27.4                             |
|                    |        | Lean Clay (CL), Light Gray mottled Yellow Brown, Black Oxidation, Stiff, Moist      | 1.25       |                        | 5.0         | 3      | SS   | 8         |            |                                           | 21.6                             |
| 10                 |        | Fat Clay (CH), Light Gray mottled Yellow Brown, Stiff, Moist                        | 1.00       |                        | 889.0       | 4      | SS   | 9         |            |                                           | 26.5                             |
|                    |        | (CH), Stiff, Moist                                                                  | 2.75       |                        | 10.0        | 5      | SS   | 13        |            |                                           | 19.5                             |
| 15                 |        | (CH), Mottled Yellow Brown/Reddish Brown, Black Oxidation, Stiff, Moist             | 2.50       |                        |             | 6      | SS   | 12        |            |                                           | 21.6                             |
|                    |        | End of Boring @ 16½ Ft.                                                             |            |                        | 882.5       |        |      |           |            |                                           |                                  |
|                    |        |                                                                                     |            |                        | 16.5        |        |      |           |            |                                           |                                  |
| 20                 |        |                                                                                     |            |                        |             |        |      |           |            |                                           |                                  |
| 25                 |        |                                                                                     |            |                        |             |        |      |           |            |                                           |                                  |
| 30                 |        |                                                                                     |            |                        |             |        |      |           |            |                                           |                                  |

Drill Method: 3 1/4" HSA with AW Rod

Boring Started: 7/22/2022

Boring Completed: 7/22/2022

Tested By: AJK/BRH/DJS/DAW/NPP

Logging By: BRH

**GEOTECHNICS**  
 Soil & Material Testing

Groundwater Elev. During Drilling: ▽

Groundwater Elev. @ Comp.: ▽

Groundwater Elev. @ 1.5 Hrs.: ▽

Boring Location: See Location Sketch

Sheet 1 of 1

Project No.: 21-5052

Project: Hallsville Middle School Classroom  
Athletic Track/Field and Improvements

Client: Hallsville R-IV School District

Boring No.: B29

## Boring Log

Rig: CME 55 (B-55)

Location: Hallsville, MO

Driller: AJK

| SUBSURFACE PROFILE |        |                                                                                                              |            |                        |               | SAMPLE |      |           |            | Standard Penetration<br>Test<br>blows/ft. | Water Content % |     |
|--------------------|--------|--------------------------------------------------------------------------------------------------------------|------------|------------------------|---------------|--------|------|-----------|------------|-------------------------------------------|-----------------|-----|
| Depth (ft.)        | Symbol | Description                                                                                                  | Qp, t.s.f. | Dry Density,<br>P.C.F. | Depth/Elev.   | Number | Type | Blows/ft. | Qu, T.S.F. |                                           | Wp              | WI  |
| 0                  |        | Ground Surface                                                                                               |            |                        | 898.9         |        |      |           |            | 10 20 30 40                               | 10 20 30 40     |     |
|                    |        | Topsoil (6")                                                                                                 |            |                        | 898.4         |        |      |           |            |                                           |                 |     |
|                    |        | Fill: Lean Clay (CL), Light Brown, Trace Crushed<br>Stone and Brick, Moist<br>Light Gravel (1 to 2½ ft.)     |            |                        | 898.4<br>0.5  | 0      | HA   |           |            |                                           | 9.9             |     |
|                    |        | Fill: Used Cuttings<br>Crushed Stone and Concrete, Light Gray, Very<br>Dense<br>Heavy Drilling (2½ to 4 ft.) |            |                        | 896.4<br>2.5  | 1      | SS   | 50/½"     |            |                                           | 50.1            | 7.5 |
| 5                  |        | Lean Clay (CL), Light Gray mottled Yellow<br>Brown, Silty, Medium, Moist<br><br>(CL), Stiff, Moist           | 0.50       | 93.3                   | 894.9<br>4.0  | 2      | SS   | 6         | 0.78       |                                           | 29.1            |     |
|                    |        |                                                                                                              | 1.50       |                        |               | 3      | SS   | 9         |            |                                           | 24.0            |     |
| 10                 |        | Fat Clay (CH), Light Gray mottled Yellow Brown,<br>Stiff, Moist<br><br>(CH), Black Oxidation, Stiff, Moist   | 1.25       |                        | 888.9<br>10.0 | 4      | SS   | 9         |            |                                           | 24.5            |     |
|                    |        |                                                                                                              | 2.75       |                        |               | 5      | SS   | 13        |            |                                           | 21.2            |     |
| 15                 |        | (CH), Stiff, Moist                                                                                           | 2.00       |                        |               | 6      | SS   | 11        |            |                                           | 22.4            |     |
|                    |        | End of Boring @ 16½ Ft.                                                                                      |            |                        | 882.4<br>16.5 |        |      |           |            |                                           |                 |     |
| 20                 |        |                                                                                                              |            |                        |               |        |      |           |            |                                           |                 |     |
| 25                 |        |                                                                                                              |            |                        |               |        |      |           |            |                                           |                 |     |
| 30                 |        |                                                                                                              |            |                        |               |        |      |           |            |                                           |                 |     |

Drill Method: 3 1/4" HSA with AW Rod

Boring Started: 7/22/2022

Boring Completed: 7/22/2022

Tested By: AJK/BRH/DJS/DAW/NPP

Logging By: BRH

**GEOTECHNICS**  
 Soil & Material Testing

Groundwater Elev. During Drilling: ▽

Groundwater Elev. @ Comp.: ▽

Groundwater Elev. @ 1 Hrs.: ▽

Boring Location: See Location Sketch

Sheet 1 of 1

Project No.: 21-5052

Project: Hallsville Middle School Classroom  
Athletic Track/Field and Improvements

Client: Hallsville R-IV School District

Boring No.: B30

**Boring Log**

Rig: CME 55 (B-55)

Location: Hallsville, MO

Driller: AJK

| SUBSURFACE PROFILE |        |                                                              |            |                        |             | SAMPLE |      |           |            | Standard Penetration<br>Test<br>blows/ft. | Water Content %<br><br>Wp ——— WI |
|--------------------|--------|--------------------------------------------------------------|------------|------------------------|-------------|--------|------|-----------|------------|-------------------------------------------|----------------------------------|
| Depth (ft.)        | Symbol | Description                                                  | Qp, t.s.f. | Dry Density,<br>P.C.F. | Depth/Elev. | Number | Type | Blows/ft. | Qu, T.S.F. |                                           |                                  |
| 0                  |        | Ground Surface                                               |            |                        | 898.9       |        |      |           |            | 10 20 30 40                               | 10 20 30 40                      |
|                    |        | Topsoil (6")                                                 |            |                        | 898.4       |        |      |           |            |                                           |                                  |
|                    |        | Lean Clay (CL), Light Brown, Moist                           |            |                        | 0.5         | 0      | HA   |           |            |                                           | 14.0                             |
|                    |        | (CL), Mottled Reddish Brown, Stiff, Moist                    | 1.50       |                        |             | 1      | SS   | 10        |            |                                           | 23.0                             |
| 5                  |        | (CL), Light Gray mottled Yellow Brown, Silty, Medium, Moist  | 1.00       |                        |             | 2      | SS   | 8         |            |                                           | 24.0                             |
|                    |        | Fat Clay (CH), Light Gray mottled Yellow Brown, Stiff, Moist | 1.00       | 100.8                  | 891.4       | 3      | SS   | 9         | 1.57       |                                           | 23.4                             |
| 10                 |        | (CH), Medium, Moist                                          | 1.50       |                        | 7.5         | 4      | SS   | 7         |            |                                           | 23.6                             |
|                    |        | (CH), Mottled Reddish Brown, Stiff, Moist                    | 2.25       |                        |             | 5      | SS   | 12        |            |                                           | 19.9                             |
| 15                 |        | (CH), Stiff, Moist                                           | 2.00       |                        |             | 6      | SS   | 11        |            |                                           | 22.6                             |
|                    |        | End of Boring @ 16½ Ft.                                      |            |                        | 882.4       |        |      |           |            |                                           |                                  |
|                    |        |                                                              |            |                        | 16.5        |        |      |           |            |                                           |                                  |
| 20                 |        |                                                              |            |                        |             |        |      |           |            |                                           |                                  |
| 25                 |        |                                                              |            |                        |             |        |      |           |            |                                           |                                  |
| 30                 |        |                                                              |            |                        |             |        |      |           |            |                                           |                                  |

Drill Method: 3 1/4" HSA with AW Rod

Boring Started: 7/22/2022

Boring Completed: 7/22/2022

Tested By: AJK/BRH/DJS/DAW/NPP

Logging By: BRH

**GEOTECHNICS**  
Soil & Material Testing

Groundwater Elev. During Drilling:

Groundwater Elev. @ Comp.:

Groundwater Elev. @ 0.5 Hrs.:

Boring Location: See Location Sketch

Sheet 1 of 1

**APPENDIX G**  
**BORING LOGS-ATHLETIC**  
**TRACK/FIELD AND IMPROVEMENTS**

Project No.: 21-5052

Project: Hallsville Middle School Classroom  
Athletic Track/Field and Improvements

Client: Hallsville R-IV School District

Boring No.: B7

**Boring Log**

Rig: CME 55 (B-55)

Location: Hallsville, MO

Driller: AJK

| SUBSURFACE PROFILE |        |                                                                  |            |                        |                              | SAMPLE |      |           |            | Standard Penetration<br>Test<br>blows/ft. | Water Content %<br><br>Wp ——— WI |
|--------------------|--------|------------------------------------------------------------------|------------|------------------------|------------------------------|--------|------|-----------|------------|-------------------------------------------|----------------------------------|
| Depth (ft.)        | Symbol | Description                                                      | Qp, t.s.f. | Dry Density,<br>P.C.F. | Depth/Elev.                  | Number | Type | Blows/ft. | Qu, T.S.F. |                                           |                                  |
| 0                  |        | Ground Surface                                                   |            |                        | 889.9                        |        |      |           |            | 10 20 30 40                               | 10 20 30 40                      |
|                    |        | Topsoil (±4")                                                    |            |                        |                              |        |      |           |            |                                           |                                  |
|                    |        | Lean Clay (CL), Yellow Brown, Silty, Stiff, Moist                | 0.75       | 106.4                  |                              | 1      | SS   | 6         | 1.67       | 6                                         | 20.0                             |
|                    |        | (CL), Mottled Light Gray, Stiff, Moist                           |            |                        |                              | 2      | SS   | 8         |            | 8                                         | 20.0                             |
| 5                  |        | Fat Clay (CH), Light Gray mottled Yellow Brown,<br>Medium, Moist | 1.00       |                        | 884.9<br>5.0<br>883.4<br>6.5 | 3      | SS   | 7         |            | 7                                         | 26.2                             |
|                    |        | End of Boring @ 6½ Ft.                                           |            |                        |                              |        |      |           |            |                                           |                                  |
| 10                 |        |                                                                  |            |                        |                              |        |      |           |            |                                           |                                  |
| 15                 |        |                                                                  |            |                        |                              |        |      |           |            |                                           |                                  |
| 20                 |        |                                                                  |            |                        |                              |        |      |           |            |                                           |                                  |
| 25                 |        |                                                                  |            |                        |                              |        |      |           |            |                                           |                                  |
| 30                 |        |                                                                  |            |                        |                              |        |      |           |            |                                           |                                  |

Drill Method: 3 1/4" HSA with AW Rod

Boring Started: 7/19/2022

Boring Completed: 7/19/2022

Tested By: AJK/BRH/DJS/DAW/NPP

Logging By: BRH

**GEOTECHNICS**  
**Soil & Material Testing**

Groundwater Elev. During Drilling: ▽

Groundwater Elev. @ Comp.: ▽

Groundwater Elev. @ Hrs.: ▽

Boring Location: See Location Sketch

Sheet 1 of 1



Project No.: 21-5052

Project: Hallsville Middle School Classroom  
Athletic Track/Field and Improvements

Client: Hallsville R-IV School District

Boring No.: B8

**Boring Log**

Rig: CME 55 (B-55)

Location: Hallsville, MO

Driller: AJK

| SUBSURFACE PROFILE |        |                                                                         |            |                        |              | SAMPLE |      |           |            | Standard Penetration<br>Test<br>blows/ft. | Water Content %<br><br>Wp ——— WI |
|--------------------|--------|-------------------------------------------------------------------------|------------|------------------------|--------------|--------|------|-----------|------------|-------------------------------------------|----------------------------------|
| Depth (ft.)        | Symbol | Description                                                             | Qp, t.s.f. | Dry Density,<br>P.C.F. | Depth/Elev.  | Number | Type | Blows/ft. | Qu, T.S.F. |                                           |                                  |
| 0                  |        | Ground Surface                                                          |            |                        | 889.5        |        |      |           |            | 10 20 30 40                               | 10 20 30 40                      |
|                    |        | Crushed Stone (±8")                                                     |            |                        | 888.8        |        |      |           |            |                                           |                                  |
|                    |        | Lean Clay (CL), Light Gray mottled Yellow<br>Brown, Silty, Stiff, Moist | 1.25       | 103.3                  | 0.7          | 1      | SS   | 12        | 1.57       | 12                                        | 20.1                             |
|                    |        | (CL), Light Brown mottled Light Gray, Silty, Stiff,<br>Moist            | 2.50       |                        |              | 2      | SS   | 12        |            | 12                                        | 18.5                             |
| 5                  |        | Fat Clay (CH), Light Brown mottled Light Gray,<br>Silty, Stiff, Moist   | 1.25       |                        | 884.5<br>5.0 | 3      | SS   | 10        |            | 10                                        | 24.6                             |
|                    |        | End of Boring @ 6½ Ft.                                                  |            |                        | 883.0<br>6.5 |        |      |           |            |                                           |                                  |
| 10                 |        |                                                                         |            |                        |              |        |      |           |            |                                           |                                  |
| 15                 |        |                                                                         |            |                        |              |        |      |           |            |                                           |                                  |
| 20                 |        |                                                                         |            |                        |              |        |      |           |            |                                           |                                  |
| 25                 |        |                                                                         |            |                        |              |        |      |           |            |                                           |                                  |
| 30                 |        |                                                                         |            |                        |              |        |      |           |            |                                           |                                  |

Drill Method: 3 1/4" HSA with AW Rod

Boring Started: 7/19/2022

Boring Completed: 7/19/2022

Tested By: AJK/BRH/DJS/DAW/NPP

Logging By: BRH

**GEOTECHNICS**  
Soil & Material Testing

Groundwater Elev. During Drilling: ▽

Groundwater Elev. @ Comp.: ▽

Groundwater Elev. @ Hrs.: ▽

Boring Location: See Location Sketch

Sheet 1 of 1

Project No.: 21-5052

Project: Hallsville Middle School Classroom  
Athletic Track/Field and Improvements

Client: Hallsville R-IV School District

Boring No.: B9

**Boring Log**

Rig: CME 55 (B-55)

Location: Hallsville, MO

Driller: AJK

| SUBSURFACE PROFILE |        |                                                                         |            |                        |             | SAMPLE |      |           |            | Standard Penetration<br>Test<br>blows/ft. | Water Content %<br><br>Wp ——— WI |
|--------------------|--------|-------------------------------------------------------------------------|------------|------------------------|-------------|--------|------|-----------|------------|-------------------------------------------|----------------------------------|
| Depth (ft.)        | Symbol | Description                                                             | Qp, t.s.f. | Dry Density,<br>P.C.F. | Depth/Elev. | Number | Type | Blows/ft. | Qu, T.S.F. |                                           |                                  |
| 0                  |        | Ground Surface                                                          |            |                        | 889.8       |        |      |           |            | 10 20 30 40                               | 10 20 30 40                      |
|                    |        | Crushed Stone (±7")                                                     |            |                        | 889.2       |        |      |           |            |                                           |                                  |
|                    |        | Lean Clay (CL), Light Gray mottled Yellow<br>Brown, Silty, Stiff, Moist | 0.75       | 90.3                   | 0.6         | 1      | SS   | 7         | 1.45       | 7                                         | 26.8                             |
|                    |        | (CL), Silty, Stiff, Moist                                               | 1.25       |                        |             | 2      | SS   | 8         |            | 8                                         | 22.4                             |
| 5                  |        | Fat Clay (CH), Light Gray mottled Yellow Brown,<br>Silty, Stiff, Moist  | 2.00       |                        | 884.8       | 3      | SS   | 10        |            | 10                                        | 20.8                             |
|                    |        |                                                                         |            |                        | 5.0         |        |      |           |            |                                           |                                  |
|                    |        |                                                                         |            |                        | 883.3       |        |      |           |            |                                           |                                  |
|                    |        | End of Boring @ 6½ Ft.                                                  |            |                        | 6.5         |        |      |           |            |                                           |                                  |
| 10                 |        |                                                                         |            |                        |             |        |      |           |            |                                           |                                  |
| 15                 |        |                                                                         |            |                        |             |        |      |           |            |                                           |                                  |
| 20                 |        |                                                                         |            |                        |             |        |      |           |            |                                           |                                  |
| 25                 |        |                                                                         |            |                        |             |        |      |           |            |                                           |                                  |
| 30                 |        |                                                                         |            |                        |             |        |      |           |            |                                           |                                  |

Drill Method: 3 1/4" HSA with AW Rod

Boring Started: 7/19/2022

Boring Completed: 7/19/2022

Tested By: AJK/BRH/DJS/DAW/NPP

Logging By: BRH

**GEOTECHNICS**  
**Soil & Material Testing**

Groundwater Elev. During Drilling: ▽

Groundwater Elev. @ Comp.: ▽

Groundwater Elev. @ Hrs.: ▽

Boring Location: See Location Sketch

Sheet 1 of 1

Project No.: 21-5052

Project: Hallsville Middle School Classroom  
Athletic Track/Field and Improvements

Client: Hallsville R-IV School District

Boring No.: B10

**Boring Log**

Rig: CME 55 (B-55)

Location: Hallsville, MO

Driller: AJK

| SUBSURFACE PROFILE |        |                                                                              |            |                        |             | SAMPLE |      |           |            | Standard Penetration<br>Test<br>blows/ft. | Water Content %<br><br>Wp ———— WI |
|--------------------|--------|------------------------------------------------------------------------------|------------|------------------------|-------------|--------|------|-----------|------------|-------------------------------------------|-----------------------------------|
| Depth (ft.)        | Symbol | Description                                                                  | Qp, t.s.f. | Dry Density,<br>P.C.F. | Depth/Elev. | Number | Type | Blows/ft. | Qu, T.S.F. |                                           |                                   |
| 0                  |        | Ground Surface                                                               |            |                        | 885.9       |        |      |           |            | 10 20 30 40                               | 10 20 30 40                       |
|                    |        | Topsoil (±5")                                                                |            |                        |             |        |      |           |            |                                           |                                   |
|                    |        | Lean Clay (CL), Light Gray mottled Yellow Brown, Silty, Medium, Moist        | 1.25       | 95.9                   |             | 1      | SS   | 7         | 0.73       |                                           | 21.5                              |
|                    |        | (CL), Silty, Stiff, Moist                                                    | 1.00       |                        |             | 2      | SS   | 8         |            |                                           | 20.3                              |
| 5                  |        | (CL), Light Gray mottled Yellow Brown, Black Oxidation, Silty, Medium, Moist | 0.75       |                        | 879.4       | 3      | SS   | 7         |            |                                           | 22.7                              |
|                    |        |                                                                              |            |                        | 6.5         |        |      |           |            |                                           |                                   |
|                    |        | End of Boring @ 6½ Ft.                                                       |            |                        |             |        |      |           |            |                                           |                                   |
| 10                 |        |                                                                              |            |                        |             |        |      |           |            |                                           |                                   |
| 15                 |        |                                                                              |            |                        |             |        |      |           |            |                                           |                                   |
| 20                 |        |                                                                              |            |                        |             |        |      |           |            |                                           |                                   |
| 25                 |        |                                                                              |            |                        |             |        |      |           |            |                                           |                                   |
| 30                 |        |                                                                              |            |                        |             |        |      |           |            |                                           |                                   |

Drill Method: 3 1/4" HSA with AW Rod

Boring Started: 7/19/2022

Boring Completed: 7/19/2022

Tested By: AJK/BRH/DJS/DAW/NPP

Logging By: BRH

**GEOTECHNICS**  
Soil & Material Testing

Groundwater Elev. During Drilling: ▽

Groundwater Elev. @ Comp.: ▽

Groundwater Elev. @ Hrs.: ▽

Boring Location: See Location Sketch

Sheet 1 of 1

Project No.: 21-5052

Project: Hallsville Middle School Classroom  
Athletic Track/Field and Improvements

Client: Hallsville R-IV School District

Boring No.: B11

**Boring Log**

Rig: CME 55 (B-55)

Location: Hallsville, MO

Driller: AJK

| SUBSURFACE PROFILE |        |                                                                       |            |                        |              | SAMPLE |      |           |            | Standard Penetration<br>Test<br>blows/ft. | Water Content %<br><br>Wp ——— WI |
|--------------------|--------|-----------------------------------------------------------------------|------------|------------------------|--------------|--------|------|-----------|------------|-------------------------------------------|----------------------------------|
| Depth (ft.)        | Symbol | Description                                                           | Qp, t.s.f. | Dry Density,<br>P.C.F. | Depth/Elev.  | Number | Type | Blows/ft. | Qu, T.S.F. |                                           |                                  |
| 0                  |        | Ground Surface                                                        |            |                        | 885.7        |        |      |           |            | 10 20 30 40                               | 10 20 30 40                      |
|                    |        | Topsoil (±2")                                                         |            |                        |              |        |      |           |            |                                           |                                  |
|                    |        | Fat Clay (CH), Light Brown mottled Reddish Brown, Silty, Stiff, Moist | 2.75       |                        |              | 1      | SS   | 9         |            | 9                                         | 20.5                             |
|                    |        | (CH), Light Gray mottled Yellow Brown, Silty, Stiff, Moist            | 2.00       | 94.2                   |              | 2      | SS   | 10        | 1.33       | 10                                        | 23.4                             |
| 5                  |        | Lean Clay (CL), Light Gray mottled Yellow Brown, Silty, Stiff, Moist  | 1.00       |                        | 880.7<br>5.0 | 3      | SS   | 8         |            | 8                                         | 20.6                             |
|                    |        | End of Boring @ 6½ Ft.                                                |            |                        | 879.2<br>6.5 |        |      |           |            |                                           |                                  |
| 10                 |        |                                                                       |            |                        |              |        |      |           |            |                                           |                                  |
| 15                 |        |                                                                       |            |                        |              |        |      |           |            |                                           |                                  |
| 20                 |        |                                                                       |            |                        |              |        |      |           |            |                                           |                                  |
| 25                 |        |                                                                       |            |                        |              |        |      |           |            |                                           |                                  |
| 30                 |        |                                                                       |            |                        |              |        |      |           |            |                                           |                                  |

Drill Method: 3 1/4" HSA with AW Rod

Boring Started: 7/19/2022

Boring Completed: 7/19/2022

Tested By: AJK/BRH/DJS/DAW/NPP

Logging By: BRH

**GEOTECHNICS**  
Soil & Material Testing

Groundwater Elev. During Drilling: ▽

Groundwater Elev. @ Comp.: ▽

Groundwater Elev. @ Hrs.: ▽

Boring Location: See Location Sketch

Sheet 1 of 1

Project No.: 21-5052

Project: Hallsville Middle School Classroom  
Athletic Track/Field and Improvements

Client: Hallsville R-IV School District

Boring No.: B12

**Boring Log**

Rig: CME 55 (B-55)

Location: Hallsville, MO

Driller: AJK

| SUBSURFACE PROFILE |        |                                                                               |            |                        |             | SAMPLE |      |           |            | Standard Penetration<br>Test<br>blows/ft. | Water Content %<br><br>Wp ——— WI |
|--------------------|--------|-------------------------------------------------------------------------------|------------|------------------------|-------------|--------|------|-----------|------------|-------------------------------------------|----------------------------------|
| Depth (ft.)        | Symbol | Description                                                                   | Qp, t.s.f. | Dry Density,<br>P.C.F. | Depth/Elev. | Number | Type | Blows/ft. | Qu, T.S.F. |                                           |                                  |
| 0                  |        | Ground Surface                                                                |            |                        | 883.3       |        |      |           |            | 10 20 30 40                               | 10 20 30 40                      |
|                    |        | Topsoil (±7")                                                                 |            |                        | 882.7       |        |      |           |            |                                           |                                  |
|                    |        | Lean Clay (CL), Light Brown mottled Reddish Brown, Stiff, Moist               |            |                        | 0.6         | 1      | SS   | 14        |            | 14                                        | 15.4                             |
|                    |        | Fat Clay (CH), Light Gray mottled Yellow Brown, Black Oxidation, Stiff, Moist | 2.00       |                        | 880.8       | 2      | SS   | 9         |            | 9                                         | 24.7                             |
| 5                  |        | (CH), Stiff, Moist                                                            | 1.75       |                        | 2.5         |        |      |           |            |                                           |                                  |
|                    |        |                                                                               |            |                        |             | 3      | SS   | 8         |            | 8                                         | 23.3                             |
|                    |        | End of Boring @ 6½ Ft.                                                        |            |                        | 876.8       |        |      |           |            |                                           |                                  |
|                    |        |                                                                               |            |                        | 6.5         |        |      |           |            |                                           |                                  |
| 10                 |        |                                                                               |            |                        |             |        |      |           |            |                                           |                                  |
| 15                 |        |                                                                               |            |                        |             |        |      |           |            |                                           |                                  |
| 20                 |        |                                                                               |            |                        |             |        |      |           |            |                                           |                                  |
| 25                 |        |                                                                               |            |                        |             |        |      |           |            |                                           |                                  |
| 30                 |        |                                                                               |            |                        |             |        |      |           |            |                                           |                                  |

Drill Method: 3 1/4" HSA with AW Rod

Boring Started: 7/19/2022

Boring Completed: 7/19/2022

Tested By: AJK/BRH/DJS/DAW/NPP

Logging By: BRH

**GEOTECHNICS**  
**Soil & Material Testing**

Groundwater Elev. During Drilling: ▽

Groundwater Elev. @ Comp.: ▽

Groundwater Elev. @ Hrs.: ▽

Boring Location: See Location Sketch

Sheet 1 of 1

Project No.: 21-5052

Project: Hallsville Middle School Classroom  
Athletic Track/Field and Improvements

Client: Hallsville R-IV School District

Boring No.: B13

**Boring Log**

Rig: CME 55 (B-55)

Location: Hallsville, MO

Driller: AJK

| SUBSURFACE PROFILE |        |                                                                      |            |                        |             | SAMPLE |      |           |            | Standard Penetration<br>Test<br>blows/ft. | Water Content %<br><br>Wp ——— WI |
|--------------------|--------|----------------------------------------------------------------------|------------|------------------------|-------------|--------|------|-----------|------------|-------------------------------------------|----------------------------------|
| Depth (ft.)        | Symbol | Description                                                          | Qp, t.s.f. | Dry Density,<br>P.C.F. | Depth/Elev. | Number | Type | Blows/ft. | Qu, T.S.F. |                                           |                                  |
| 0                  |        | Ground Surface                                                       |            |                        | 890.8       |        |      |           |            | 10 20 30 40                               | 10 20 30 40                      |
|                    |        | Crushed Stone (±8")                                                  |            |                        | 890.1       |        |      |           |            |                                           |                                  |
|                    |        | Fat Clay (CH), Brown mottled Light Brown, Silty, Moist               |            |                        | 0.7         | 0      | HA   |           |            |                                           | 23.6                             |
|                    |        |                                                                      |            |                        | 888.3       |        |      |           |            |                                           |                                  |
|                    |        | Lean Clay (CL), Light Gray mottled Yellow Brown, Silty, Stiff, Moist | 1.00       | 105.9                  | 2.5         | 1      | SS   | 9         | 1.64       | 9                                         | 20.2                             |
| 5                  |        | (CL), Black Oxidation, Silty, Stiff, Moist                           | 1.75       |                        |             | 2      | SS   | 9         |            | 9                                         | 23.2                             |
|                    |        |                                                                      |            |                        | 883.3       |        |      |           |            |                                           |                                  |
|                    |        | Fat Clay (CH), Light Gray mottled Yellow Brown, Medium, Moist        | 2.00       | 104.6                  | 7.5         | 3      | ST   |           | 0.72       |                                           | 22.9                             |
| 10                 |        | (CH), Stiff, Moist                                                   | 2.25       |                        |             | 4      | SS   | 11        |            | 11                                        | 22.8                             |
|                    |        | (CH), Stiff, Moist                                                   | 2.00       |                        |             | 5      | SS   | 12        |            | 12                                        | 22.5                             |
| 15                 |        | (CH), Black Oxidation, Stiff, Moist                                  | 1.75       |                        |             | 6      | SS   | 10        |            | 10                                        | 23.4                             |
|                    |        | End of Boring @ 16½ Ft.                                              |            |                        | 874.3       |        |      |           |            |                                           |                                  |
|                    |        |                                                                      |            |                        | 16.5        |        |      |           |            |                                           |                                  |
| 20                 |        |                                                                      |            |                        |             |        |      |           |            |                                           |                                  |
| 25                 |        |                                                                      |            |                        |             |        |      |           |            |                                           |                                  |
| 30                 |        |                                                                      |            |                        |             |        |      |           |            |                                           |                                  |

Drill Method: 3 1/4" HSA with AW Rod

Boring Started: 7/21/2022

Boring Completed: 7/21/2022

Tested By: AJK/BRH/DJS/DAW/NPP

Logging By: BRH

**GEOTECHNICS**  
 Soil & Material Testing

Groundwater Elev. During Drilling: ▽

Groundwater Elev. @ Comp.: ▽

Groundwater Elev. @ Hrs.: ▽

Boring Location: See Location Sketch

Sheet 1 of 1

Project No.: 21-5052

Project: Hallsville Middle School Classroom  
Athletic Track/Field and Improvements

Client: Hallsville R-IV School District

Boring No.: B14

**Boring Log**

Rig: CME 55 (B-55)

Location: Hallsville, MO

Driller: AJK

| SUBSURFACE PROFILE |        |                                                                                            |            |                        |             | SAMPLE |      |           |            | Standard Penetration<br>Test<br>blows/ft. | Water Content %<br><br>Wp ——— WI |
|--------------------|--------|--------------------------------------------------------------------------------------------|------------|------------------------|-------------|--------|------|-----------|------------|-------------------------------------------|----------------------------------|
| Depth (ft.)        | Symbol | Description                                                                                | Qp, t.s.f. | Dry Density,<br>P.C.F. | Depth/Elev. | Number | Type | Blows/ft. | Qu, T.S.F. |                                           |                                  |
| 0                  |        | Ground Surface                                                                             |            |                        | 890.0       |        |      |           |            | 10 20 30 40                               | 10 20 30 40                      |
|                    |        | Topsoil (±6")                                                                              |            |                        | 889.5       |        |      |           |            |                                           |                                  |
|                    |        | Lean Clay (CL), Light Gray mottled Reddish<br>Brown, Black Oxidation, Silty, Medium, Moist | 0.75       | 89.4                   | 0.5         | 1      | SS   | 5         | 0.82       | 5                                         | 27.4                             |
|                    |        | (CL), Yellow Brown mottled Light Gray, Silty,<br>Medium, Moist                             | 0.50       | 92.3                   |             | 2      | SS   | 8         | 0.93       | 8                                         | 23.7                             |
| 5                  |        | (CL), Silty, Very Stiff, Moist                                                             | 1.50       | 105.7                  |             | 3      | ST   |           | 2.27       |                                           | 20.0                             |
|                    |        | Fat Clay (CH), Light Gray mottled Yellow Brown,<br>Very Stiff, Moist                       | 1.25       | 101.1                  | 882.5       | 4      | SS   | 9         | 2.10       | 9                                         | 23.9                             |
| 10                 |        | (CH), Stiff, Moist                                                                         | 2.50       |                        | 7.5         | 5      | SS   | 11        |            | 11                                        | 20.5                             |
|                    |        | (CH), Stiff, Moist                                                                         | 2.00       |                        |             | 6      | SS   | 11        |            | 11                                        | 22.0                             |
| 15                 |        | (CH), Stiff, Moist                                                                         | 2.25       |                        |             | 7      | SS   | 11        |            | 11                                        | 20.8                             |
|                    |        | End of Boring @ 16½ Ft.                                                                    |            |                        | 873.5       |        |      |           |            |                                           |                                  |
|                    |        |                                                                                            |            |                        | 16.5        |        |      |           |            |                                           |                                  |
| 20                 |        |                                                                                            |            |                        |             |        |      |           |            |                                           |                                  |
| 25                 |        |                                                                                            |            |                        |             |        |      |           |            |                                           |                                  |
| 30                 |        |                                                                                            |            |                        |             |        |      |           |            |                                           |                                  |

Drill Method: 3 1/4" HSA with AW Rod

Boring Started: 7/21/2022

Boring Completed: 7/21/2022

Tested By: AJK/BRH/DJS/DAW/NPP

Logging By: BRH

**GEOTECHNICS**  
 Soil & Material Testing

Groundwater Elev. During Drilling: ▽

Groundwater Elev. @ Comp.: ▽

Groundwater Elev. @ Hrs.: ▽

Boring Location: See Location Sketch

Sheet 1 of 1

Project No.: 21-5052

Project: Hallsville Middle School Classroom  
Athletic Track/Field and Improvements

Client: Hallsville R-IV School District

Boring No.: B15

**Boring Log**

Rig: CME 55 (B-55)

Location: Hallsville, MO

Driller: AJK

| SUBSURFACE PROFILE |        |                                                                         |            |                        |             | SAMPLE |      |           |            | Standard Penetration<br>Test<br>blows/ft. | Water Content %<br><br>Wp ——— WI |
|--------------------|--------|-------------------------------------------------------------------------|------------|------------------------|-------------|--------|------|-----------|------------|-------------------------------------------|----------------------------------|
| Depth (ft.)        | Symbol | Description                                                             | Qp, t.s.f. | Dry Density,<br>P.C.F. | Depth/Elev. | Number | Type | Blows/ft. | Qu, T.S.F. |                                           |                                  |
| 0                  |        | Ground Surface                                                          |            |                        | 889.2       |        |      |           |            | 10 20 30 40                               | 10 20 30 40                      |
|                    |        | Topsoil (±7")                                                           |            |                        | 888.6       |        |      |           |            |                                           |                                  |
|                    |        | Fat Clay (CH), Yellow Brown mottled Light Gray,<br>Stiff, Moist         | 1.00       |                        | 0.6         | 1      | SS   | 8         |            | 8                                         | 29.1                             |
|                    |        | Lean Clay (CL), Light Gray mottled Yellow<br>Brown, Silty, Stiff, Moist | 1.00       | 94.0                   | 886.7       | 2      | SS   | 7         | 1.23       | 7                                         | 25.7                             |
| 5                  |        | (CL), Silty, Very Stiff, Moist                                          | 1.75       | 107.9                  | 2.5         | 3      | ST   |           | 2.56       |                                           | 18.8                             |
|                    |        | Fat Clay (CH), Light Gray mottled Yellow Brown,<br>Stiff, Moist         | 1.00       |                        | 881.7       | 4      | SS   | 8         |            | 8                                         | 26.9                             |
| 10                 |        | (CH), Stiff, Moist                                                      | 1.25       |                        | 7.5         | 5      | SS   | 8         |            | 8                                         | 22.2                             |
|                    |        | (CH), Stiff, Moist                                                      | 2.00       |                        |             | 6      | SS   | 10        |            | 10                                        | 22.5                             |
| 15                 |        | (CH), Trace Sand, Stiff, Moist                                          | 2.25       |                        |             | 7      | SS   | 11        |            | 11                                        | 22.8                             |
|                    |        | End of Boring @ 16½ Ft.                                                 |            |                        | 872.7       |        |      |           |            |                                           |                                  |
|                    |        |                                                                         |            |                        | 16.5        |        |      |           |            |                                           |                                  |
| 20                 |        |                                                                         |            |                        |             |        |      |           |            |                                           |                                  |
| 25                 |        |                                                                         |            |                        |             |        |      |           |            |                                           |                                  |
| 30                 |        |                                                                         |            |                        |             |        |      |           |            |                                           |                                  |

Drill Method: 3 1/4" HSA with AW Rod

Boring Started: 7/19/2022

Boring Completed: 7/19/2022

Tested By: AJK/BRH/DJS/DAW/NPP

Logging By: BRH

**GEOTECHNICS**  
Soil & Material Testing

Groundwater Elev. During Drilling: ▽

Groundwater Elev. @ Comp.: ▽

Groundwater Elev. @ Hrs.: ▽

Boring Location: See Location Sketch

Sheet 1 of 1



Project No.: 21-5052

Project: Hallsville Middle School Classroom  
Athletic Track/Field and Improvements

Client: Hallsville R-IV School District

Boring No.: B16

**Boring Log**

Rig: CME 55 (B-55)

Location: Hallsville, MO

Driller: AJK

| SUBSURFACE PROFILE |        |                                                                           |            |                        |             | SAMPLE |      |           |            | Standard Penetration<br>Test<br>blows/ft. | Water Content %<br><br>Wp ——— WI |
|--------------------|--------|---------------------------------------------------------------------------|------------|------------------------|-------------|--------|------|-----------|------------|-------------------------------------------|----------------------------------|
| Depth (ft.)        | Symbol | Description                                                               | Qp, t.s.f. | Dry Density,<br>P.C.F. | Depth/Elev. | Number | Type | Blows/ft. | Qu, T.S.F. |                                           |                                  |
| 0                  |        | Ground Surface                                                            |            |                        | 889.6       |        |      |           |            |                                           |                                  |
|                    |        | Crushed Stone (±8")                                                       |            |                        | 888.9       |        |      |           |            |                                           |                                  |
|                    |        | Fill: Lean Clay (CL), Light Gray mottled Brown, Silty, Moist              |            |                        | 0.7         | 0      | HA   |           |            |                                           | 22.6                             |
|                    |        | Fill: (CL), Light Greenish-Gray mottled Dark Gray, Medium, Moist          | 0.50       | 89.2                   |             | 1      | SS   | 3         | 0.59       | 3                                         | 30.8                             |
| 5                  |        | Fill: (CL), Stiff, Moist                                                  | 1.00       |                        |             | 2      | SS   | 8         |            | 8                                         | 25.7                             |
|                    |        | Lean Clay (CL), Light Gray mottled Yellow Brown, Silty, Very Stiff, Moist | 1.25       | 105.0                  | 882.1       | 3      | SS   | 10        | 2.17       | 10                                        | 21.9                             |
| 10                 |        | (CL), Silty, Very Stiff, Moist                                            | 1.50       | 103.0                  | 7.5         | 4      | ST   |           | 2.24       |                                           | 21.3                             |
|                    |        | Fat Clay (CH), Light Gray, Stiff, Moist                                   | 1.00       |                        | 877.1       | 5      | SS   | 10        |            | 10                                        | 22.1                             |
| 15                 |        | (CH), Mottled Reddish Brown, Stiff, Moist                                 | 1.25       |                        | 12.5        | 6      | SS   | 11        |            | 11                                        | 23.6                             |
|                    |        | End of Boring @ 16½ Ft.                                                   |            |                        | 873.1       |        |      |           |            |                                           |                                  |
| 20                 |        |                                                                           |            |                        | 16.5        |        |      |           |            |                                           |                                  |
| 25                 |        |                                                                           |            |                        |             |        |      |           |            |                                           |                                  |
| 30                 |        |                                                                           |            |                        |             |        |      |           |            |                                           |                                  |

Drill Method: 3 1/4" HSA with AW Rod

Boring Started: 7/21/2022

Boring Completed: 7/21/2022

Tested By: AJK/BRH/DJS/DAW/NPP

Logging By: BRH

**GEOTECHNICS**  
 Soil & Material Testing

Groundwater Elev. During Drilling: ▽

Groundwater Elev. @ Comp.: ▽

Groundwater Elev. @ Hrs.: ▽

Boring Location: See Location Sketch

Sheet 1 of 1

Project No.: 21-5052

Project: Hallsville Middle School Classroom  
Athletic Track/Field and Improvements

Client: Hallsville R-IV School District

Boring No.: B17

**Boring Log**

Rig: CME 55 (B-55)

Location: Hallsville, MO

Driller: AJK

| SUBSURFACE PROFILE |        |                                                               |            |                        |               | SAMPLE |      |           |            | Standard Penetration<br>Test<br>blows/ft. | Water Content %<br><br>Wp ——— WI |
|--------------------|--------|---------------------------------------------------------------|------------|------------------------|---------------|--------|------|-----------|------------|-------------------------------------------|----------------------------------|
| Depth (ft.)        | Symbol | Description                                                   | Qp, t.s.f. | Dry Density,<br>P.C.F. | Depth/Elev.   | Number | Type | Blows/ft. | Qu, T.S.F. |                                           |                                  |
| 0                  |        | Ground Surface                                                |            |                        | 887.9         |        |      |           |            | 10 20 30 40                               | 10 20 30 40                      |
|                    |        | Topsoil (±7")                                                 |            |                        | 887.2         |        |      |           |            |                                           |                                  |
|                    |        | Lean Clay (CL), Light Brown, Silty, Moist                     |            |                        | 0.7           | 0      | HA   |           |            |                                           | 15.6                             |
|                    |        | (CL), Light Gray mottled Yellow Brown, Silty, Medium, Moist   | 2.50       |                        |               | 1      | SS   | 7         |            | 7                                         | 22.2                             |
| 5                  |        | (CL), mottled Light Brown/Reddish Brown, Stiff, Moist         | 1.75       |                        |               | 2      | SS   | 12        |            | 12                                        | 29.2                             |
|                    |        | (CL), Silty, Medium, Moist                                    | 0.75       | 99.8                   |               | 3      | SS   | 8         | 0.99       | 8                                         | 22.6                             |
| 10                 |        | Fat Clay (CH), Light Gray mottled Reddish Brown, Stiff, Moist | 2.00       |                        | 877.9<br>10.0 | 4      | ST   | 9         |            | 9                                         | 21.7                             |
|                    |        | (CH), Stiff, Moist                                            | 2.00       |                        |               | 5      | SS   | 12        |            | 12                                        | 20.4                             |
| 15                 |        | (CH), Stiff, Moist                                            | 1.75       |                        | 871.4<br>16.5 | 6      | SS   | 10        |            | 10                                        | 21.7                             |
|                    |        | End of Boring @ 16½ Ft.                                       |            |                        |               |        |      |           |            |                                           |                                  |
| 20                 |        |                                                               |            |                        |               |        |      |           |            |                                           |                                  |
| 25                 |        |                                                               |            |                        |               |        |      |           |            |                                           |                                  |
| 30                 |        |                                                               |            |                        |               |        |      |           |            |                                           |                                  |

Drill Method: 3 1/4" HSA with AW Rod

Boring Started: 7/19/2022

Boring Completed: 7/19/2022

Tested By: AJK/BRH/DJS/DAW/NPP

Logging By: BRH

**GEOTECHNICS**  
 Soil & Material Testing

Groundwater Elev. During Drilling: ▽

Groundwater Elev. @ Comp.: ▽

Groundwater Elev. @ 6 Hrs.: ▽

Boring Location: See Location Sketch

Sheet 1 of 1

Project No.: 21-5052

Project: Hallsville Middle School Classroom  
Athletic Track/Field and Improvements

Client: Hallsville R-IV School District

Boring No.: B18

**Boring Log**

Rig: CME 55 (B-55)

Location: Hallsville, MO

Driller: AJK

| SUBSURFACE PROFILE |        |                                                                     |            |                        |               | SAMPLE |      |           |            | Standard Penetration<br>Test<br>blows/ft. | Water Content %<br><br>Wp ——— WI |
|--------------------|--------|---------------------------------------------------------------------|------------|------------------------|---------------|--------|------|-----------|------------|-------------------------------------------|----------------------------------|
| Depth (ft.)        | Symbol | Description                                                         | Qp, t.s.f. | Dry Density,<br>P.C.F. | Depth/Elev.   | Number | Type | Blows/ft. | Qu, T.S.F. |                                           |                                  |
| 0                  |        | Ground Surface                                                      |            |                        | 885.5         |        |      |           |            | 10 20 30 40                               | 10 20 30 40                      |
|                    |        | Topsoil (±7")                                                       |            |                        | 884.9         |        |      |           |            |                                           |                                  |
|                    |        | Possible Fill: Fat Clay (CH), Light Brown, Silty, Moist             |            |                        | 0.6           | 0      | HA   |           |            |                                           | 14.9                             |
|                    |        | Possible Fill: (CH), Light Gray mottled Reddish Brown, Hard, Moist  | 3.25       | 98.9                   |               | 1      | SS   | 14        | 6.02       | 14                                        | 21.9                             |
| 5                  |        | Possible Fill: (CH), Light Brown, Silty, Very Stiff, Moist          |            |                        |               | 2      | SS   | 17        |            | 17                                        | 9.3                              |
|                    |        | Fat Clay (CH), Light Gray mottled Yellow Brown, Silty, Stiff, Moist | 1.50       | 99.3                   |               | 3      | SS   | 9         | 1.69       | 9                                         | 21.9                             |
| 10                 |        | (CH), Stiff, Moist                                                  | 2.00       |                        |               | 4      | SS   | 9         |            | 9                                         | 22.9                             |
|                    |        | (CH), Stiff, Moist                                                  | 2.25       |                        |               | 5      | SS   | 12        |            | 12                                        | 19.8                             |
| 15                 |        | (CH), Trace Sand, Stiff, Moist                                      | 3.00       |                        |               | 6      | SS   | 13        |            | 13                                        | 18.0                             |
|                    |        | End of Boring @ 16½ Ft.                                             |            |                        | 869.0<br>16.5 |        |      |           |            |                                           |                                  |

Drill Method: 3 1/4" HSA with AW Rod

Boring Started: 7/19/2022

Boring Completed: 7/19/2022

Tested By: AJK/BRH/DJS/DAW/NPP

Logging By: BRH

**GEOTECHNICS**  
 Soil & Material Testing

Groundwater Elev. During Drilling: ▽

Groundwater Elev. @ Comp.: ▽

Groundwater Elev. @ 6.5 Hrs.: ▽

Boring Location: See Location Sketch

Sheet 1 of 1

Project No.: 21-5052

Project: Hallsville Middle School Classroom  
Athletic Track/Field and Improvements

Client: Hallsville R-IV School District

Boring No.: B19

**Boring Log**

Rig: CME 55 (B-55)

Location: Hallsville, MO

Driller: AJK

| SUBSURFACE PROFILE |        |                                                                                                      |            |                        |             | SAMPLE |      |           |            | Standard Penetration<br>Test<br>blows/ft. | Water Content %<br><br>Wp ——— WI |
|--------------------|--------|------------------------------------------------------------------------------------------------------|------------|------------------------|-------------|--------|------|-----------|------------|-------------------------------------------|----------------------------------|
| Depth (ft.)        | Symbol | Description                                                                                          | Qp, t.s.f. | Dry Density,<br>P.C.F. | Depth/Elev. | Number | Type | Blows/ft. | Qu, T.S.F. |                                           |                                  |
| 0                  |        | Ground Surface                                                                                       |            |                        | 887.8       |        |      |           |            | 10 20 30 40                               | 10 20 30 40                      |
|                    |        | Topsoil (±7")                                                                                        |            |                        | 887.2       |        |      |           |            |                                           |                                  |
|                    |        | Fill: Fat Clay (CH), Light Gray mottled Light Brown/Yellow Brown, Black Oxidation, Very Stiff, Moist | 4.5+       |                        | 0.6         |        |      |           |            |                                           |                                  |
|                    |        | Possible Fill: Fat Clay (CH), Light Gray mottled Yellow Brown, Hard, Moist                           | 4.25       | 105.7                  | 885.3       | 1      | SS   | 22        | 5.25       | 22                                        | 14.7                             |
|                    |        |                                                                                                      |            |                        | 2.5         | 2      | SS   | 11        |            | 11                                        | 18.7                             |
| 5                  |        | Fat Clay (CH), Light Gray mottled Reddish Brown, Very Stiff, Moist                                   | 4.00       |                        |             | 3      | SS   | 15        |            | 15                                        | 19.9                             |
|                    |        | (CH), Mottled Yellow Brown, Stiff, Moist                                                             | 3.00       |                        |             | 4      | SS   | 14        |            | 14                                        | 20.8                             |
| 10                 |        | (CH), Stiff, Moist                                                                                   | 2.25       | 102.4                  |             | 5      | SS   | 12        | 1.61       | 12                                        | 22.4                             |
|                    |        | (CH), Black Oxidation, Trace Sand, Stiff, Moist                                                      | 1.75       |                        |             | 6      | SS   | 10        |            | 10                                        | 23.0                             |
| 15                 |        | (CH), Trace Sand, Stiff, Moist                                                                       | 2.25       |                        |             | 7      | SS   | 12        |            | 12                                        | 19.5                             |
|                    |        | End of Boring @ 16½ Ft.                                                                              |            |                        | 871.3       |        |      |           |            |                                           |                                  |
|                    |        |                                                                                                      |            |                        | 16.5        |        |      |           |            |                                           |                                  |

Drill Method: 3 1/4" HSA with AW Rod

Boring Started: 7/21/2022

Boring Completed: 7/21/2022

Tested By: AJK/BRH/DJS/DAW/NPP

Logging By: BRH

**GEOTECHNICS**  
**Soil & Material Testing**

Groundwater Elev. During Drilling: ▽

Groundwater Elev. @ Comp.: ▽

Groundwater Elev. @ Hrs.: ▽

Boring Location: See Location Sketch

Sheet 1 of 1

Project No.: 21-5052

Project: Hallsville Middle School Classroom  
Athletic Track/Field and Improvements

Client: Hallsville R-IV School District

Boring No.: B20

**Boring Log**

Rig: CME 55 (B-55)

Location: Hallsville, MO

Driller: AJK

| SUBSURFACE PROFILE |        |                                                                 |            |                        |               | SAMPLE |      |           |            | Standard Penetration<br>Test<br>blows/ft. | Water Content %<br><br>Wp ——— WI |
|--------------------|--------|-----------------------------------------------------------------|------------|------------------------|---------------|--------|------|-----------|------------|-------------------------------------------|----------------------------------|
| Depth (ft.)        | Symbol | Description                                                     | Qp, t.s.f. | Dry Density,<br>P.C.F. | Depth/Elev.   | Number | Type | Blows/ft. | Qu, T.S.F. |                                           |                                  |
| 0                  |        | Ground Surface                                                  |            |                        | 889.7         |        |      |           |            | 10 20 30 40                               | 10 20 30 40                      |
|                    |        | Topsoil (±3")                                                   |            |                        |               |        |      |           |            |                                           |                                  |
|                    |        | Fat Clay (CH), Light Gray mottled Yellow Brown,<br>Stiff, Moist | 0.25       |                        |               | 1      | SS   | 11        |            | 11                                        | 20.3                             |
|                    |        | (CH), Medium, Moist                                             | 1.25       |                        |               | 2      | SS   | 6         |            | 6                                         | 21.0                             |
| 5                  |        | (CH), Stiff, Moist                                              | 1.75       | 101.1                  |               | 3      | SS   | 9         | 1.87       | 9                                         | 24.3                             |
|                    |        | (CH), Reddish Brown Oxidation, Very Stiff, Moist                | 2.25       | 104.0                  |               | 4      | SS   | 13        | 2.66       | 13                                        | 21.7                             |
| 10                 |        | (CH), Stiff, Moist                                              | 2.25       |                        |               | 5      | SS   | 13        |            | 13                                        | 22.2                             |
|                    |        | (CH), Stiff, Moist                                              | 2.25       |                        |               | 6      | SS   | 12        |            | 12                                        | 24.2                             |
| 15                 |        | (CH), Light Gray, Black Oxidation, Stiff, Moist                 | 1.50       |                        |               | 7      | SS   | 11        |            | 11                                        | 22.6                             |
|                    |        | End of Boring @ 16½ Ft.                                         |            |                        | 873.2<br>16.5 |        |      |           |            |                                           |                                  |
| 20                 |        |                                                                 |            |                        |               |        |      |           |            |                                           |                                  |
| 25                 |        |                                                                 |            |                        |               |        |      |           |            |                                           |                                  |
| 30                 |        |                                                                 |            |                        |               |        |      |           |            |                                           |                                  |

Drill Method: 3 1/4" HSA with AW Rod

Boring Started: 7/21/2022

Boring Completed: 7/21/2022

Tested By: AJK/BRH/DJS/DAW/NPP

Logging By: BRH

**GEOTECHNICS**  
**Soil & Material Testing**

Groundwater Elev. During Drilling: ▽

Groundwater Elev. @ Comp.: ▽

Groundwater Elev. @ Hrs.: ▽

Boring Location: See Location Sketch

Sheet 1 of 1

Project No.: 21-5052

Project: Hallsville Middle School Classroom  
Athletic Track/Field and Improvements

Client: Hallsville R-IV School District

Boring No.: B21

**Boring Log**

Rig: CME 55 (B-55)

Location: Hallsville, MO

Driller: AJK

| SUBSURFACE PROFILE |        |                                                                                  |            |                        |             | SAMPLE |      |           |            | Standard Penetration<br>Test<br>blows/ft. | Water Content %<br><br>Wp ——— WI |
|--------------------|--------|----------------------------------------------------------------------------------|------------|------------------------|-------------|--------|------|-----------|------------|-------------------------------------------|----------------------------------|
| Depth (ft.)        | Symbol | Description                                                                      | Qp, t.s.f. | Dry Density,<br>P.C.F. | Depth/Elev. | Number | Type | Blows/ft. | Qu, T.S.F. |                                           |                                  |
| 0                  |        | Ground Surface                                                                   |            |                        | 883.6       |        |      |           |            | 10 20 30 40                               | 10 20 30 40                      |
|                    |        | Topsoil (±7")                                                                    |            |                        | 883.0       |        |      |           |            |                                           |                                  |
|                    |        | Fill: Lean Clay (CL), Light Brown mottled Yellow Brown, Silty, Very Stiff, Moist |            |                        | 0.6         |        |      |           |            |                                           |                                  |
|                    |        | Possible Fill: Fat Clay (CH), Light Gray mottled Yellow Brown, Hard, Moist       | 4.5+       | 110.3                  | 881.1       | 1      | SS   | 22        | 6.64       | 22                                        | 9.9                              |
|                    |        |                                                                                  |            |                        | 2.5         | 2      | SS   | 11        |            | 11                                        | 15.4                             |
| 5                  |        | Fat Clay (CH), Light Gray, Stiff, Moist                                          | 3.50       |                        |             |        |      |           |            |                                           |                                  |
|                    |        | (CH), Stiff, Moist                                                               | 2.25       | 98.2                   |             | 3      | SS   | 14        | 1.99       | 14                                        | 18.6                             |
| 10                 |        | (CH), Very Stiff, Moist                                                          | 1.50       | 100.2                  |             | 4      | ST   |           |            |                                           | 27.8                             |
|                    |        | (CH), Mottled Yellow Brown, Stiff, Moist                                         | 1.75       |                        |             | 5      | SS   | 8         | 2.10       | 8                                         | 25.5                             |
| 15                 |        | (CH), Light Gray, Trace Sand, Stiff, Moist                                       | 2.00       |                        |             | 6      | SS   | 10        |            | 10                                        | 21.2                             |
|                    |        |                                                                                  |            |                        |             | 7      | SS   | 9         |            | 9                                         | 20.2                             |
|                    |        | End of Boring @ 16½ Ft.                                                          |            |                        | 867.1       |        |      |           |            |                                           |                                  |
|                    |        |                                                                                  |            |                        | 16.5        |        |      |           |            |                                           |                                  |
| 20                 |        |                                                                                  |            |                        |             |        |      |           |            |                                           |                                  |
| 25                 |        |                                                                                  |            |                        |             |        |      |           |            |                                           |                                  |
| 30                 |        |                                                                                  |            |                        |             |        |      |           |            |                                           |                                  |

Drill Method: 3 1/4" HSA with AW Rod

Boring Started: 7/19/2022

Boring Completed: 7/19/2022

Tested By: AJK/BRH/DJS/DAW/NPP

Logging By: BRH

**GEOTECHNICS**  
Soil & Material Testing

Groundwater Elev. During Drilling: ▽

Groundwater Elev. @ Comp.: ▽

Groundwater Elev. @ Hrs.: ▽

Boring Location: See Location Sketch

Sheet 1 of 1

Project No.: 21-5052

Project: Hallsville Middle School Classroom  
Athletic Track/Field and Improvements

Client: Hallsville R-IV School District

Boring No.: B22

**Boring Log**

Rig: CME 55 (B-55)

Location: Hallsville, MO

Driller: AJK

| SUBSURFACE PROFILE |        |                                                                           |            |                        |             | SAMPLE |      |           |            | Standard Penetration<br>Test<br>blows/ft. | Water Content %<br><br>Wp ——— WI |
|--------------------|--------|---------------------------------------------------------------------------|------------|------------------------|-------------|--------|------|-----------|------------|-------------------------------------------|----------------------------------|
| Depth (ft.)        | Symbol | Description                                                               | Qp, t.s.f. | Dry Density,<br>P.C.F. | Depth/Elev. | Number | Type | Blows/ft. | Qu, T.S.F. |                                           |                                  |
| 0                  |        | Ground Surface                                                            |            |                        | 883.1       |        |      |           |            | 10 20 30 40                               | 10 20 30 40                      |
|                    |        | Topsoil (±7")                                                             |            |                        | 882.5       |        |      |           |            |                                           |                                  |
|                    |        | Lean Clay (CL), Light Brown mottled Reddish Brown, Stiff, Moist           |            |                        | 0.6         | 1      | SS   | 14        |            | 14                                        | 12.0                             |
|                    |        | Fat Clay (CH), Light Brown/Reddish Brown, Stiff, Moist                    | 1.00       | 100.9                  | 880.6       | 2      | SS   | 7         | 1.64       | 7                                         | 22.3                             |
|                    |        |                                                                           |            |                        | 2.5         |        |      |           |            |                                           |                                  |
|                    |        |                                                                           |            |                        | 879.1       |        |      |           |            |                                           |                                  |
| 5                  |        | Lean Clay (CL), Light Gray mottled Yellow Brown, Silty, Stiff, Moist      | 0.75       |                        | 4.0         | 3      | SS   | 9         |            | 9                                         | 22.4                             |
|                    |        |                                                                           |            |                        |             |        |      |           |            |                                           |                                  |
|                    |        | Fat Clay (CH), Light Gray mottled Yellow Brown, Stiff, Moist              | 1.75       | 102.4                  | 875.6       | 4      | SS   | 10        | 1.73       | 10                                        | 23.1                             |
|                    |        |                                                                           |            |                        | 7.5         |        |      |           |            |                                           |                                  |
| 10                 |        | (CH), Trace Sand, Stiff, Moist                                            | 2.25       |                        |             | 5      | SS   | 11        |            | 11                                        | 20.9                             |
|                    |        |                                                                           |            |                        |             |        |      |           |            |                                           |                                  |
|                    |        | (CH), Trace Sand, Stiff, Moist                                            | 1.50       |                        |             | 6      | SS   | 10        |            | 10                                        | 24.3                             |
|                    |        |                                                                           |            |                        |             |        |      |           |            |                                           |                                  |
| 15                 |        | Lean Clay (CL), Yellow Brown mottled Light Gray, Trace Sand, Stiff, Moist |            |                        | 868.1       | 7      | SS   | 9         |            | 9                                         | 18.5                             |
|                    |        |                                                                           |            |                        | 15.0        |        |      |           |            |                                           |                                  |
|                    |        |                                                                           |            |                        | 866.6       |        |      |           |            |                                           |                                  |
|                    |        |                                                                           |            |                        | 16.5        |        |      |           |            |                                           |                                  |
|                    |        | End of Boring @ 16½ Ft.                                                   |            |                        |             |        |      |           |            |                                           |                                  |
| 20                 |        |                                                                           |            |                        |             |        |      |           |            |                                           |                                  |
| 25                 |        |                                                                           |            |                        |             |        |      |           |            |                                           |                                  |
| 30                 |        |                                                                           |            |                        |             |        |      |           |            |                                           |                                  |

Drill Method: 3 1/4" HSA with AW Rod

Boring Started: 7/19/2022

Boring Completed: 7/19/2022

Tested By: AJK/BRH/DJS/DAW/NPP

Logging By: BRH

**GEOTECHNICS**  
 Soil & Material Testing

Groundwater Elev. During Drilling: ▽

Groundwater Elev. @ Comp.: ▽

Groundwater Elev. @ Hrs.: ▽

Boring Location: See Location Sketch

Sheet 1 of 1

Project No.: 21-5052

Project: Hallsville Middle School Classroom  
Athletic Track/Field and Improvements

Client: Hallsville R-IV School District

Boring No.: B23

**Boring Log**

Rig: CME 55 (B-55)

Location: Hallsville, MO

Driller: AJK

| SUBSURFACE PROFILE |        |                                                                                |            |                        |             | SAMPLE |      |           |            | Standard Penetration<br>Test<br>blows/ft. | Water Content %<br><br>Wp ——— WI |
|--------------------|--------|--------------------------------------------------------------------------------|------------|------------------------|-------------|--------|------|-----------|------------|-------------------------------------------|----------------------------------|
| Depth (ft.)        | Symbol | Description                                                                    | Qp, t.s.f. | Dry Density,<br>P.C.F. | Depth/Elev. | Number | Type | Blows/ft. | Qu, T.S.F. |                                           |                                  |
| 0                  |        | Ground Surface                                                                 |            |                        | 885.8       |        |      |           |            | 10 20 30 40                               | 10 20 30 40                      |
|                    |        | Topsoil (±7")                                                                  |            |                        | 885.2       |        |      |           |            |                                           |                                  |
|                    |        | Lean Clay (CL), Light Brown, Medium, Moist                                     |            |                        | 0.6         | 1      | SS   | 7         |            | 7                                         | 18.0                             |
|                    |        | (CL), Trace Sand, Medium, Moist                                                |            |                        |             | 2      | SS   | 4         |            | 4                                         | 30.6                             |
| 5                  |        | Fat Clay (CH), Light Gray mottled Reddish<br>Brown, Trace Sand, Stiff, Moist   | 0.50       | 96.5                   | 880.8       | 3      | SS   | 6         | 1.77       | 6                                         | 24.7                             |
|                    |        | (CH), Mottled Yellow Brown, Stiff, Moist                                       | 2.00       |                        | 5.0         | 4      | SS   | 10        |            | 10                                        | 22.7                             |
| 10                 |        | (CH), Trace Sand, Medium, Moist                                                | 1.00       | 90.9                   |             | 5      | SS   | 7         | 0.78       | 7                                         | 32.2                             |
|                    |        | (CH), Trace Sand, Stiff, Moist                                                 | 1.00       |                        |             | 6      | SS   | 8         |            | 8                                         | 21.8                             |
| 15                 |        | Fat Clay with Sand (CH), Light Gray mottled<br>Yellow Brown, Very Stiff, Moist | 2.25       |                        | 870.8       | 7      | SS   | 15        |            | 15                                        | 16.3                             |
|                    |        |                                                                                |            |                        | 15.0        |        |      |           |            |                                           |                                  |
|                    |        | End of Boring @ 16½ Ft.                                                        |            |                        | 869.3       |        |      |           |            |                                           |                                  |
|                    |        |                                                                                |            |                        | 16.5        |        |      |           |            |                                           |                                  |
| 20                 |        |                                                                                |            |                        |             |        |      |           |            |                                           |                                  |
| 25                 |        |                                                                                |            |                        |             |        |      |           |            |                                           |                                  |
| 30                 |        |                                                                                |            |                        |             |        |      |           |            |                                           |                                  |

Drill Method: 3 1/4" HSA with AW Rod

Boring Started: 7/19/2022

Boring Completed: 7/19/2022

Tested By: AJK/BRH/DJS/DAW/NPP

Logging By: BRH

**GEOTECHNICS**  
Soil & Material Testing

Groundwater Elev. During Drilling: ▽

Groundwater Elev. @ Comp.: ▽

Groundwater Elev. @ Hrs.: ▽

Boring Location: See Location Sketch

Sheet 1 of 1



Project No.: 21-5052

Project: Hallsville Middle School Classroom  
Athletic Track/Field and Improvements

Client: Hallsville R-IV School District

Boring No.: B24

**Boring Log**

Rig: 3" Hand Auger

Location: Hallsville, MO

Driller: AJK

| SUBSURFACE PROFILE |        |                                                                                                                      |            |                        |             | SAMPLE |      |           |            | Standard Penetration<br>Test<br>blows/ft. | Water Content %<br><br>Wp ——— WI |
|--------------------|--------|----------------------------------------------------------------------------------------------------------------------|------------|------------------------|-------------|--------|------|-----------|------------|-------------------------------------------|----------------------------------|
| Depth (ft.)        | Symbol | Description                                                                                                          | Qp, t.s.f. | Dry Density,<br>P.C.F. | Depth/Elev. | Number | Type | Blows/ft. | Qu, T.S.F. |                                           |                                  |
| 0                  |        | Ground Surface                                                                                                       |            |                        | 888.8       |        |      |           |            | 10 20 30 40                               | 10 20 30 40                      |
|                    |        | Topsoil (±6")                                                                                                        |            |                        |             | 1      | HA   |           |            |                                           | 21.2                             |
|                    |        | Lean Clay (CL), Light Brown, Silty, Moist<br>(CL), Light Gray mottled Yellow Brown, Black<br>Oxidation, Silty, Moist |            |                        |             | 2      | HA   |           |            |                                           | 19.7                             |
| 2.5                |        |                                                                                                                      |            |                        | 884.8       |        |      |           |            |                                           |                                  |
|                    |        | Fat Clay (CH), Light Gray mottled Yellow Brown,<br>Trace Sand, Moist                                                 | 1.25       |                        | 4.0         | 3      | ST   |           |            |                                           | 22.6                             |
| 5                  |        | (CH), Moist                                                                                                          |            |                        |             | 4      | HA   |           |            |                                           | 25.3                             |
|                    |        | (CH), Moist                                                                                                          |            |                        |             | 5      | HA   |           |            |                                           | 22.7                             |
| 7.5                |        |                                                                                                                      |            |                        | 880.8       |        |      |           |            |                                           |                                  |
|                    |        | End of Boring @ 8 Ft.                                                                                                |            |                        | 8.0         |        |      |           |            |                                           |                                  |
| 10                 |        |                                                                                                                      |            |                        |             |        |      |           |            |                                           |                                  |
| 12.5               |        |                                                                                                                      |            |                        |             |        |      |           |            |                                           |                                  |
| 15                 |        |                                                                                                                      |            |                        |             |        |      |           |            |                                           |                                  |

Drill Method: Hand Auger

Boring Started: 7/18/2022

Boring Completed: 7/18/2022

Tested By: AJK/BRH/DJS/DAW/NPP

Logging By: BRH

**GEOTECHNICS**  
**Soil & Material Testing**

Groundwater Elev. During Drilling: ▽

Groundwater Elev. @ Comp.: ▽

Groundwater Elev. @ Hrs.: ▽

Boring Location: See Location Sketch

Sheet 1 of 1

Project No.: 21-5052

Project: Hallsville Middle School Classroom  
Athletic Track/Field and Improvements

Client: Hallsville R-IV School District

Boring No.: B25

**Boring Log**

Rig: 3" Hand Auger

Location: Hallsville, MO

Driller: AJK

| SUBSURFACE PROFILE |        |                                                     |            |                        |              | SAMPLE |      |           |            | Standard Penetration<br>Test<br>blows/ft. | Water Content %<br><br>Wp ——— WI |
|--------------------|--------|-----------------------------------------------------|------------|------------------------|--------------|--------|------|-----------|------------|-------------------------------------------|----------------------------------|
| Depth (ft.)        | Symbol | Description                                         | Qp, t.s.f. | Dry Density,<br>P.C.F. | Depth/Elev.  | Number | Type | Blows/ft. | Qu, T.S.F. |                                           |                                  |
| 0                  |        | Ground Surface                                      |            |                        | 889.1        |        |      |           |            | 10 20 30 40                               | 10 20 30 40                      |
|                    |        | Topsoil (±4")                                       |            |                        |              | 1      | HA   |           |            |                                           | 24.7                             |
|                    |        | Fat Clay (CH), Brown, Silty, Moist                  |            |                        |              |        |      |           |            |                                           |                                  |
|                    |        | (CH), Light Brown mottled Reddish Brown, Moist      | 4.5+       |                        |              | 2      | ST   |           |            |                                           | 23.2                             |
|                    |        | (CH), Light Gray mottled Yellow Brown, Silty, Moist |            |                        |              |        |      |           |            |                                           | 70                               |
| 2.5                |        |                                                     |            |                        |              |        |      |           |            |                                           |                                  |
|                    |        | (CH), Moist                                         |            |                        |              | 3      | HA   |           |            |                                           | 20.3                             |
| 5                  |        |                                                     |            |                        |              |        |      |           |            |                                           |                                  |
|                    |        |                                                     |            |                        |              | 4      | HA   |           |            |                                           | 22.6                             |
| 7.5                |        |                                                     |            |                        | 881.1<br>8.0 |        |      |           |            |                                           |                                  |
|                    |        | End of Boring @ 8 Ft.                               |            |                        |              |        |      |           |            |                                           |                                  |
| 10                 |        |                                                     |            |                        |              |        |      |           |            |                                           |                                  |
|                    |        |                                                     |            |                        |              |        |      |           |            |                                           |                                  |
| 12.5               |        |                                                     |            |                        |              |        |      |           |            |                                           |                                  |
|                    |        |                                                     |            |                        |              |        |      |           |            |                                           |                                  |
| 15                 |        |                                                     |            |                        |              |        |      |           |            |                                           |                                  |

Drill Method: Hand Auger

Boring Started: 7/18/2022

Boring Completed: 7/18/2022

Tested By: AJK/BRH/DJS/DAW/NPP

Logging By: BRH

**GEOTECHNICS**  
**Soil & Material Testing**

Groundwater Elev. During Drilling: ▽

Groundwater Elev. @ Comp.: ▽

Groundwater Elev. @ Hrs.: ▽

Boring Location: See Location Sketch

Sheet 1 of 1

Project No.: 21-5052

Project: Hallsville Middle School Classroom  
Athletic Track/Field and Improvements

Client: Hallsville R-IV School District

Boring No.: B26

**Boring Log**

Rig: 3" Hand Auger

Location: Hallsville, MO

Driller: AJK

| SUBSURFACE PROFILE |        |                                                                               |            |                        |              | SAMPLE |      |           |            | Standard Penetration<br>Test<br>blows/ft. | Water Content %<br><br>Wp ——— WI |
|--------------------|--------|-------------------------------------------------------------------------------|------------|------------------------|--------------|--------|------|-----------|------------|-------------------------------------------|----------------------------------|
| Depth (ft.)        | Symbol | Description                                                                   | Qp, t.s.f. | Dry Density,<br>P.C.F. | Depth/Elev.  | Number | Type | Blows/ft. | Qu, T.S.F. |                                           |                                  |
| 0                  |        | Ground Surface                                                                |            |                        | 888.8        |        |      |           |            | 10 20 30 40                               | 10 20 30 40                      |
|                    |        | Topsoil (±4")                                                                 |            |                        |              |        |      |           |            |                                           |                                  |
|                    |        | Possible Fill: Fat Clay (CH), Light Brown mottled<br>Light Gray, Silty, Moist |            |                        |              | 1      | HA   |           |            |                                           | 17.3                             |
| 2.5                |        | Possible Fill: (CH), Light Gray mottled Light<br>Brown, Moist                 | 0.50       |                        |              | 2      | ST   |           |            |                                           | 26.1                             |
|                    |        | Fat Clay (CH), Light Brown mottled Yellow<br>Brown, Silty, Moist              |            |                        |              | 3      | HA   |           |            |                                           | 21.3                             |
|                    |        | (CH), Light Brown/Reddish Brown mottled Light<br>Gray, Moist                  |            |                        |              | 4      | HA   |           |            |                                           | 33.3                             |
| 5                  |        | Lean Clay (CL), Light Gray mottled Yellow<br>Brown, Silty, Wet                |            |                        | 883.6<br>5.2 | 5      | HA   |           |            |                                           | 21.6                             |
| 7.5                |        | (CL), Silty                                                                   |            |                        |              | 6      | HA   |           |            |                                           | 23.0                             |
|                    |        | End of Boring @ 8.3 Ft.                                                       |            |                        | 880.6<br>8.3 |        |      |           |            |                                           |                                  |
| 10                 |        |                                                                               |            |                        |              |        |      |           |            |                                           |                                  |
| 12.5               |        |                                                                               |            |                        |              |        |      |           |            |                                           |                                  |
| 15                 |        |                                                                               |            |                        |              |        |      |           |            |                                           |                                  |

Drill Method: Hand Auger

Boring Started: 7/18/2022

Boring Completed: 7/18/2022

Tested By: AJK/BRH/DJS/DAW/NPP

Logging By: BRH

**GEOTECHNICS**  
 Soil & Material Testing

Groundwater Elev. During Drilling: 881.8

Groundwater Elev. @ Comp.: 881.0

Groundwater Elev. @ Hrs.: 881.0

Boring Location: See Location Sketch

Sheet 1 of 1

Project No.: 21-5052

Project: Hallsville Middle School Classroom  
Athletic Track/Field and Improvements

Client: Hallsville R-IV School District

Boring No.: B27

**Boring Log**

Rig: 3" Hand Auger

Location: Hallsville, MO

Driller: AJK

| SUBSURFACE PROFILE |        |                                                                 |            |                        |             | SAMPLE |      |           |            | Standard Penetration<br>Test<br>blows/ft. | Water Content %<br><br>Wp ——— WI |
|--------------------|--------|-----------------------------------------------------------------|------------|------------------------|-------------|--------|------|-----------|------------|-------------------------------------------|----------------------------------|
| Depth (ft.)        | Symbol | Description                                                     | Qp, t.s.f. | Dry Density,<br>P.C.F. | Depth/Elev. | Number | Type | Blows/ft. | Qu, T.S.F. |                                           |                                  |
| 0                  |        | Ground Surface                                                  |            |                        | 889.1       |        |      |           |            | 10 20 30 40                               | 10 20 30 40                      |
|                    |        | Topsoil (±4")                                                   |            |                        |             | 1      | HA   |           |            |                                           | 18.1                             |
|                    |        | Lean Clay (CL), Light Brown mottled Light Gray,<br>Silty, Moist |            |                        |             |        |      |           |            |                                           |                                  |
|                    |        | (CL), Black Oxidation, Moist                                    |            |                        |             | 2      | HA   |           |            |                                           | 23.3                             |
| 2.5                |        |                                                                 |            |                        | 885.9       |        |      |           |            |                                           |                                  |
|                    |        | Fat Clay (CH), Light Gray mottled Yellow Brown,<br>Silty, Moist |            |                        | 3.3         | 3      | HA   |           |            |                                           | 28.3                             |
|                    |        | (CH), Wet                                                       |            |                        |             | 4      | ST   |           |            |                                           | 35.0                             |
| 5                  |        |                                                                 | 0.75       |                        | 883.8       |        |      |           |            |                                           |                                  |
|                    |        | Lean Clay (CL), Light Gray mottled Yellow<br>Brown, Silty       |            |                        | 5.3         | 5      | HA   |           |            |                                           | 25.8                             |
| 7.5                |        |                                                                 |            |                        | 880.9       |        |      |           |            |                                           |                                  |
|                    |        | End of Boring @ 8.2 Ft.                                         |            |                        | 8.2         |        |      |           |            |                                           |                                  |
| 10                 |        |                                                                 |            |                        |             |        |      |           |            |                                           |                                  |
| 12.5               |        |                                                                 |            |                        |             |        |      |           |            |                                           |                                  |
| 15                 |        |                                                                 |            |                        |             |        |      |           |            |                                           |                                  |

Drill Method: Hand Auger

Boring Started: 7/18/2022

Boring Completed: 7/18/2022

Tested By: AJK/BRH/DJS/DAW/NPP

Logging By: BRH

**GEOTECHNICS**  
 Soil & Material Testing

Groundwater Elev. During Drilling: 884.9

Groundwater Elev. @ Comp.: 884.9

Groundwater Elev. @ Hrs.: 884.9

Boring Location: See Location Sketch

Sheet 1 of 1

**SECTION 031000**  
**CONCRETE FORMS AND ACCESSORIES**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
  - 1. Formwork for cast-in place concrete.
  - 2. Shoring, bracing, and anchorage.
  - 3. Form accessories.
  - 4. Form stripping.
- B. Related Sections:
  - 1. Section 032000 - Concrete Reinforcing.
  - 2. Section 033000 - Cast-In-Place Concrete.

**1.2 SYSTEM DESCRIPTION**

- A. Design, engineer and construct formwork, shoring and bracing in accordance with ACI 318 to conform to design and International Building Code requirements.
- B. Vapor Retarder Permeance: Maximum 1 perm when tested according to ASTM E96.

**1.3 REFERENCES**

- A. American Concrete Institute:
  - 1. ACI 117 - Standard Specifications for Tolerances for Concrete Construction and Materials.
  - 2. ACI 301 - Specifications for Structural Concrete.
  - 3. ACI 318 - Building Code Requirements for Structural Concrete.
  - 4. ACI 347 - Guide to Formwork for Concrete.
- B. American Forest and Paper Association:
  - 1. AF&PA - National Design Specifications for Wood Construction.
- C. The Engineered Wood Association:
  - 1. APA/EWA PS 1 - Voluntary Product Standard for Construction and Industrial Plywood.
- D. American Society of Mechanical Engineers:
  - 1. ASME A17.1 - Safety Code for Elevators and Escalators.
- E. ASTM International:

1. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types).
2. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.

F. West Coast Lumber Inspection Bureau:

1. WCLIB - Standard Grading Rules for West Coast Lumber.

1.4 SUBMITTALS

- A. Manufacturer and type of void forms including compressive strengths.

1.5 QUALITY ASSURANCE

- A. Perform Work according to ACI 347, ACI 318 and ACI 301
- B. For wood products, comply with ANSI/AF&PA National Design Specification (NDS).

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver void forms and installation instructions in manufacturer's packaging.
- B. Store off ground in ventilated and protected manner to prevent deterioration from moisture.

1.7 COORDINATION

- A. Coordinate this Section with other sections of work, requiring attachment of components to formwork.

**PART 2 - PRODUCTS**

2.1 MATERIALS

A. Forms for Surfaces Exposed to View:

1. Wood forms:
  - a. New 5/8 or 3/4 IN 5-ply structural plywood of concrete form grade.
  - b. Built-in-place or prefabricated type panel.
  - c. 4 x 8 FT sheets for built-in-place type except where smaller pieces will cover entire 40 area.
  - d. When approved, plywood may be reused.
2. Metal forms:
  - a. Metal forms excluding aluminum may be used.

3. Forms to be tight to prevent leakage, free of rust and straight without dents to provide 45 members of uniform thickness.

B. Forms for Surfaces Not Exposed to View:

1. Wood or metal sufficiently tight to prevent leakage.
2. Do not use aluminum forms.

C. Or as approved by Engineer.

## 2.2 PREFABRICATED FORMS

- A. Preformed Steel Forms: Minimum 16 gage matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished surfaces.
- B. Glass Fiber Fabric Reinforced Plastic Forms: Matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished concrete surfaces.
- C. Pan Type: Steel or Glass fiber and of size and profile required.
- D. Tubular Column Type: Round, spirally wound laminated fiber, wood, or glass fiber material, surface treated with release agent, non-reusable.
- E. Void Forms: Moisture resistant treated paper faces, biodegradable, structurally sufficient to support weight of wet concrete mix until initial set.
- F. Steel Forms: Sheet steel, suitably reinforced, and designed for particular use indicated on Drawings.
- G. Framing, Studding and Bracing: Stud or No. 3 structural light framing grade.

## 2.3 FORMWORK ACCESSORIES

- A. Form Ties: Removable or Snap-off type, galvanized metal, fixed or adjustable length, free of defects capable of leaving holes larger than 1 inch in concrete surface.
- B. Spreaders: Standard, non-corrosive metal form clamp assembly, of type acting as spreaders and leaving no metal within 1 inch of concrete face. Wire ties, wood spreaders or through-bolts not permitted.
- C. Form Anchors and Hangers:
  1. Do not use anchors and hangers exposed concrete leaving exposed metal at concrete surface.
  2. Symmetrically arrange hangers supporting forms from structural steel members to minimize twisting or rotation of member.
  3. Penetration of structural steel members is not permitted.
- D. Form Release Agent: Colorless mineral oil that will not stain concrete, or absorb moisture or impair natural bonding or color characteristics of coating intended for use on concrete.

- E. Corners: Chamfer, rigid plastic or wood strip type; 3/4 x 3/4 inch size; maximum possible lengths.
- F. Dovetail Anchor Slot: Galvanized steel, 22 gage thick, release tape sealed slots, anchors for securing to concrete formwork.
- G. Flashing Reglets: Galvanized steel or Rigid PVC, 22 gage thick, longest possible lengths, with alignment splines for joints, release tape sealed slots, anchors for securing to concrete formwork.
- H. Vapor Retarder: Where indicated on Drawings, 8 mil thick polyethylene sheet.
- I. Bituminous Joint Filler: ASTM D1751.
- J. Nails, Spikes, Lag Bolts, Through-bolts, Anchorages: Size, strength and character to maintain formwork in place while placing concrete.

## 2.4 COATINGS

- A. Coatings for Aluminum: Polyamide epoxy finish coat with paint manufacturer's recommended primer for aluminum substrate. Apply one coat primer and one coat finish.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify lines, levels, and centers before proceeding with formwork. Verify dimensions agree with Drawings.
- B. When formwork is placed after reinforcement resulting in insufficient concrete cover over reinforcement before proceeding, request instructions from Engineer.

### 3.2 INSTALLATION

- A. Formwork - General:
  - 1. Construct forms to correct shape and dimensions, mortar-tight, braced, and of sufficient strength to maintain shape and position under imposed loads from construction operations.
  - 2. Camber forms where necessary to produce level finished soffits unless otherwise shown on Drawings.
  - 3. Carefully verify horizontal and vertical positions of forms. Correct misaligned or misplaced forms before placing concrete.
  - 4. Complete wedging and bracing before placing concrete.
- B. Forms for Smooth Finish Concrete:
  - 1. Use steel, plywood or lined board forms.
  - 2. Use clean and smooth plywood and form liners, uniform in size, and free from surface and edge damage capable of affecting resulting concrete finish.



3. Install form lining with close-fitting square joints between separate sheets without springing into place.
4. Use full size sheets of form lines and plywood wherever possible.
5. Tape joints to prevent protrusions in concrete.
6. Use care in forming and stripping wood forms to protect corners and edges.
7. Level and continue horizontal joints.
8. Keep wood forms wet until stripped.

C. Framing, Studding and Bracing:

1. Space studs at 16 inches o.c. maximum for boards and 12 inches on center maximum for plywood.
  2. Size framing, bracing, centering, and supporting members with sufficient strength to maintain shape and position under imposed loads from construction operations.
  3. Construct beam soffits of material minimum of 2 inches thick.
  4. Distribute bracing loads over base area on which bracing is erected.
  5. When placed on ground, protect against undermining, settlement or accidental impact.
- D. Erect formwork, shoring, and bracing to achieve design requirements, in accordance with requirements of ACI 301 and ACI 318.
- E. Arrange and assemble formwork to permit dismantling and stripping. Do not damage concrete during stripping. Permit removal of remaining principal shores.
- F. Obtain Engineer's approval before framing openings in structural members not indicated on Drawings.
- G. Install chamfer strips on exposed corners.
- H. Install void forms in accordance with manufacturer's recommendations.
- I. Do not patch formwork.

### 3.3 APPLICATION - FORM RELEASE AGENT

- A. Apply form release agent on formwork in accordance with manufacturer's recommendations.
- B. Apply prior to placement of reinforcing steel, anchoring devices, and embedded items.
- C. Do not apply form release agent where concrete surfaces are indicated to receive special finishes or applied coverings that are affected by agent. Soak inside surfaces of untreated forms with clean water. Keep surfaces coated prior to placement of concrete.
- D. Reuse and Coating of Forms: Thoroughly clean forms and reapply form coating before each reuse. For exposed work, do not reuse forms with damaged faces or edges. Apply form coating to forms in accordance with manufacturer's specifications. Do not coat forms for concrete indicated to receive "scored finish." Apply form coatings before placing reinforcing steel.

### 3.4 INSTALLATION - INSERTS, EMBEDDED PARTS, AND OPENINGS

- A. Install formed openings for items to be embedded in or passing through concrete Work.
- B. Locate and set in place items required to be cast directly into concrete.

- C. Coordinate with Work of other sections in forming and placing openings, slots, reglets, recesses, sleeves, bolts, anchors, other inserts, and components of other Work.
- D. Install accessories straight, level, and plumb. Ensure items are not disturbed during concrete placement.
- E. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain.
- F. Close temporary openings with tight fitting panels, flush with inside face of forms, and neatly fitted so joints will not be apparent in exposed concrete surfaces.
- G. Form Ties:
  - 1. Use sufficient strength and sufficient quantity to prevent spreading of forms.
  - 2. Place ties at least 1 inch away from finished surface of concrete.
  - 3. Leave inner rods in concrete when forms are stripped.
  - 4. Space form ties equidistant, symmetrical and aligned vertically and horizontally unless otherwise shown on Drawings.
- H. Arrangement: Arrange formwork to allow proper erection sequence and to permit form removal without damage to concrete.
- I. Construction Joints:
  - 1. Install surfaced pouring strip where construction joints intersect exposed surfaces to provide straight line at joints.
  - 2. Just prior to subsequent concrete placement, remove strip and tighten forms to conceal shrinkage.
  - 3. Show no overlapping of construction joints. Construct joints to present same appearance as butted plywood joints.
  - 4. Arrange joints in continuous line straight, true and sharp.
- J. Embedded Items:
  - 1. Make provisions for pipes, sleeves, anchors, inserts, reglets, anchor slots, nailers, water stops, and other features.
  - 2. Do not embed wood or uncoated aluminum in concrete.
  - 3. Obtain installation and setting information for embedded items furnished under other Specification sections.
  - 4. Securely anchor embedded items in correct location and alignment prior to placing concrete.
  - 5. Verify conduits and pipes, including those made of coated aluminum, meet requirements of ACI 318 for size and location limitations.
- K. Openings for Items Passing Through Concrete:
  - 1. Frame openings in concrete where indicated on Drawings. Establish exact locations, sizes, and other conditions required for openings and attachment of work specified under other sections.
  - 2. Coordinate work to avoid cutting and patching of concrete after placement.
  - 3. Perform cutting and repairing of concrete required as result of failure to provide required openings.
- L. Screeds:

1. Set screeds and establish levels for tops of concrete slabs and levels for finish on slabs.
2. Slope slabs to drain where required or as indicated on Drawings.
3. Before depositing concrete, remove debris from space to be occupied by concrete and thoroughly wet forms. Remove freestanding water.

M. Screed Supports:

1. For concrete over waterproof membranes and vapor retarder membranes, use cradle, pad or base type screed supports which will not puncture membrane.
2. Staking through membrane is not permitted.

N. Cleanouts and Access Panels:

1. Provide removable cleanout sections or access panels at bottoms of forms to permit inspection and effective cleaning of loose dirt, debris and waste material.
2. Clean forms and surfaces against which concrete is to be placed. Remove chips, saw dust and other debris. Thoroughly blow out forms with compressed air just before concrete is placed.

### 3.5 FORM CLEANING

- A. Clean forms as erection proceeds, to remove foreign matter within forms.
- B. Clean formed cavities of debris prior to placing concrete.
- C. Flush with water or use compressed air to remove remaining foreign matter. Ensure that water and debris drain to exterior through clean-out ports.
- D. During cold weather, remove ice and snow from within forms. Do not use de-icing salts. Do not use water to clean out forms, unless formwork and concrete construction proceed within heated enclosure. Use compressed air or other means to remove foreign matter.

### 3.6 FORM REMOVAL

- A. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads and removal has been approved by Architect/Engineer.
- B. Loosen forms carefully. Do not wedge pry bars, hammers, or tools against finish concrete surfaces scheduled for exposure to view.
- C. Store removed forms in manner that surfaces to be in contact with fresh concrete will not be damaged. Discard damaged forms.
- D. Leave forms in place for minimum number of days as specified in ACI 347.

### 3.7 FORMWORK

A. Cleaning:

1. Clean forms as erection proceeds.
2. Clean formed cavities of debris.
3. Flush with water or use compressed air.

4. During cold weather:
  - a. Remove ice and snow from within forms.
  - b. Do not use de-icing salts.
  - c. Do not use water
  - d. Use compressed air to remove foreign matter.

B. Removal:

1. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads.
2. Loosen forms carefully. Do not wedge tools against finish concrete surfaces.
3. Leave forms in place for minimum number of days according to ACI 347.

3.8 ERECTION TOLERANCES

- A. Tolerances: Construct formwork to produce completed concrete surfaces within construction tolerances according to ACI 117.
- B. Camber slabs and beams 1/4 inch per 10 feet in accordance with ACI 301.

3.9 FIELD QUALITY CONTROL

- A. Owner will engage a qualified testing and inspecting agency to perform field special structural inspections and testing in accordance with the applicable International Building Code and to submit reports.
- B. Inspect erected formwork, shoring, and bracing to ensure that Work is in accordance with formwork design, and that supports, fastenings, wedges, ties, and items are secure.
- C. Notify Engineer after placement of reinforcing steel in forms, but prior to placing concrete.
- D. Schedule concrete placement to permit formwork inspection before placing concrete.
- E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or corrective work.

END OF SECTION 031000

## **SECTION 032000 CONCRETE REINFORCING**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

**A. Work includes**

1. Provide complete, in place, all concrete reinforcement required for all cast-in-place concrete work for the project, as shown or noted on the drawings and as specified herein.

**B. Related work**

1. Specified elsewhere
  - a. Concrete forming specified in Section 031100.
  - b. Concrete accessories specified in Section 031500.
  - c. Cast-in-place concrete specified in Section 033000.

#### **1.2 SUBMITTALS**

**A. Shop drawings**

1. Submit for Architect's approval:
  - a. Complete fabrication and layout drawings covering all details of concrete reinforcement, including bar schedules, stirrup spacing, diagrams of bent bars, and arrangements and assemblies.
2. Detail shop drawings in accordance with ACI 315.

#### **1.3 QUALITY ASSURANCE**

**A. Standards**

1. Any procedure, material, or operation specified by reference to the following standards, specifications, or codes shall comply with the current or most recent issue.
2. Work of this section shall comply with all pertinent provisions of the following:
  - a. American Society for Testing and Materials (ASTM) Specifications as listed elsewhere for various materials required.
  - b. Concrete Reinforcing Steel Institute (CRSI) "Manual of Standard Practice".
  - c. American Concrete Institute (ACI) ACI 318.

#### **1.4 PRODUCT HANDLING**

- A. Deliver reinforcement to job site bundled, tagged, and marked. Use metal tags indicating bar size, lengths, and other information corresponding to markings shown on shop drawings.**

- B. Store reinforcement at job site in a manner to prevent damage and accumulation of dirt and excessive rust.

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- A. Bar Reinforcing - ASTM A 615, Grade 60, sizes as detailed or noted on the drawings.
  - 1. Mat fabrication - ASTM A 184.
- B. Steel Wire - ASTM A 82.
- C. Mesh reinforcing - ASTM A 185, Welded Steel Wire Fabric, sizes and weights as detailed or noted on the drawings.
- D. Supports for Reinforcement - Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcement in place:
  - 1. Use wire bar type supports complying with CRSI recommendations, unless otherwise indicated on the drawings.
  - 2. Do not use wood, brick, or other unacceptable materials.
  - 3. For slabs on grade, use supports with sand plates or horizontal runners where base material will not support chair legs.
  - 4. For exposed to view concrete surfaces, where legs of supports are in contact with forms, provide supports with either hot-dipped galvanized or plastic protected legs.

### **2.2 FABRICATION**

- A. General - Fabricate reinforcing bars to conform to required shapes and dimensions, with fabrication tolerances complying with CRSI Manual. In case of fabrication errors, do not straighten bars in a manner that will injure or weaken the material.
- B. Bars shall be bent cold. Bend & hooks shall conform to ACI 318.
- C. Unacceptable materials - reinforcement with any of the following defects will not be permitted in the work:
  - 1. Bar lengths, depths, and bends exceeding specified fabrication tolerances.
  - 2. Bends or kinks not indicated on drawings or final shop drawings.
  - 3. Bars with reduced cross-section due to excessive rusting or other cause.

## **PART 3 - EXECUTION**

### **3.1 INSPECTION**

- A. Examine the substrate, formwork, and the conditions under which concrete reinforcement is to be placed. Do not proceed with the work until all unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. General - Comply with the specified standards for details and methods of reinforcement placement and supports, and as herein specified.
- B. Clean reinforcement to remove loose rust and mill scale, earth, and other materials which reduce or destroy bond with concrete.
  - 1. At time concrete is placed, metal reinforcement shall be free from rust, scale, oil, grease, dirt or other foreign material.
- C. Reinforcement shall be accurately positioned and firmly secured against displacement.
  - 1. Arrange, space, and securely tie bars and bar supports together to hold accurately in position during concrete operation.
    - a. Wire tie or clip at all intersections.
  - 2. Provide spacers, support bars, chairs and bolsters in accordance with CRSI-75. All such items in areas of exposed concrete shall be galvanized or plastic covered.
- D. During placement of concrete the position and condition of all reinforcement shall be constantly monitored by qualified workmen to assure compliance with specified clearances.
- E. Clearances (face of concrete to near edge of rebar):
  - 1. Footings: 3 inches.
  - 2. Walls: 1-1/2 inches.
  - 3. Beams & Columns: 1-1/2 inches.
  - 4. Slabs on Grade: Center of slab unless noted otherwise on drawings.
  - 5. Backfill surfaces: 2 inches.

END OF SECTION 032000

**SECTION 033000**  
**CAST-IN-PLACE CONCRETE**

**PART 1 - GENERAL**

**1.1 SUMMARY**

A. Section includes cast-in-place concrete for the following:

1. Foundations.
2. Slabs on grade.
3. Control, expansion and contraction joint devices.
4. Equipment pads.
5. Concrete Toppings.
6. Other items as indicated on drawings.

B. Related Sections:

1. Section 031000 - Concrete Forming and Accessories
2. Section 032000 - Concrete Reinforcing.

**1.2 REFERENCES**

A. American Concrete Institute:

1. ACI 301 - Specifications for Structural Concrete.
2. ACI 305 - Hot Weather Concreting.
3. ACI 306.1 - Standard Specification for Cold Weather Concreting.
4. ACI 308.1 - Standard Specification for Curing Concrete.
5. ACI 318 - Building Code Requirements for Structural Concrete.

B. ASTM International:

1. ASTM C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
2. ASTM C33 - Standard Specification for Concrete Aggregates.
3. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
4. ASTM C42 - Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
5. ASTM C94 - Standard Specification for Ready-Mixed Concrete.
6. ASTM C143 - Standard Test Method for Slump of Hydraulic Cement Concrete.
7. ASTM C150 - Standard Specification for Portland Cement.
8. ASTM C172 - Standard Practice for Sampling Freshly Mixed Concrete.
9. ASTM C173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
10. ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
11. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
12. ASTM C330 - Standard Specification for Lightweight Aggregates for Structural Concrete.
13. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete.



14. ASTM C595 - Standard Specification for Blended Hydraulic Cements.
15. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.
16. ASTM C685 - Standard Specification for Concrete Made By Volumetric Batching and Continuous Mixing.
17. ASTM C845 - Standard Specification for Expansive Hydraulic Cement.
18. ASTM C989 - Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars.
19. ASTM C1017 - Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
20. ASTM C1064 - Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete.
21. ASTM C1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
22. ASTM C1116 - Standard Specification for Fiber-Reinforced Concrete and Shotcrete.
23. ASTM C1157 - Standard Performance Specification for Hydraulic Cement.
24. ASTM C1218 - Standard Test Method for Water-Soluble Chloride in Mortar and Concrete.
25. ASTM C1240 - Standard Specification for Silica Fume Used in Cementitious Mixtures.
26. ASTM D994 - Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
27. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
28. ASTM D1752 - Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
29. ASTM D6690 - Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.
30. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.
31. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
32. ASTM E1643 - Standard Practice for Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill under Concrete Slabs.
33. ASTM E1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs.

### 1.3 SUBMITTALS

- A. Product Data: Submit data on joint devices, attachment accessories and admixtures.
- B. Design Data:
  1. Submit concrete mix design for each concrete strength. Submit separate mix designs when admixtures are required for the following:
    - a. Hot and cold weather concrete work.
    - b. Air entrained concrete work.
  2. Identify mix ingredients and proportions, including admixtures.
  3. Identify chloride content of admixtures and whether or not chloride was added during manufacture.
- C. Manufacturer's Installation Instructions: Submit installation procedures and interface required with adjacent Work.

1.4 QUALITY ASSURANCE.

- A. Perform Work in accordance with ACI 301 and ACI 318.
- B. Conform to ACI 305 when concreting during hot weather.
- C. Conform to ACI 306.1 when concreting during cold weather.
- D. Acquire cement and aggregate from one source for Work.

1.5 ENVIRONMENTAL REQUIREMENTS

- A. Maintain concrete temperature after installation at minimum 50 degrees F for minimum 7 days.
- B. Maintain high early strength concrete temperature after installation at minimum 50 degrees F for minimum 3 days.

1.6 COORDINATION

- A. Coordinate placement of joint devices with erection of concrete formwork and placement of form accessories.

**PART 2 - PRODUCTS**

2.1 CONCRETE MATERIALS

- A. Cement: ASTM C150; Portland Type: Type I - Normal, Type IA - Air Entraining
- B. Normal Weight Aggregates: ASTM C33.
  - 1. Coarse Aggregate Maximum Size: 3/4 inches, In accordance with ACI 318.
- C. Water: ACI 318; potable, without deleterious amounts of chloride ions.

2.2 ADMIXTURES

- A. Air Entrainment: ASTM C260.
- B. Chemical: ASTM C494.
  - 1. Type A - Water Reducing.
  - 2. Type B - Retarding.
  - 3. Type C - Accelerating.
  - 4. Type D - Water Reducing and Retarding.
  - 5. Type E - Water Reducing and Accelerating.
  - 6. Type F - Water Reducing, High Range.
  - 7. Type G - Water Reducing, High Range and Retarding.
- C. Fly Ash: ASTM C618 Class C or F.

- D. Silica Fume: ASTM C1240
- E. Slag: ASTM C989; ground granulated blast furnace slag
- F. Plasticizing: ASTM C1017/C1017M.
  - 1. Type I, plasticizing.
  - 2. Type II, plasticizing and retarding.

## 2.3 ACCESSORIES

- A. Bonding Agent:
  - 1. Manufactures:
    - a. Sika – Sikadur 32 High-Mod.
    - b. Euclid – Duralbond.
    - c. Substitutions: Permitted upon approval of Engineer
- B. Vapor Retarder: ASTM E1745 Class A 15 vapor barrier; type recommended for below grade application. Furnish joint tape recommended by manufacturer.
  - 1. Manufactures:
    - a. Stego Industries, LLC, Stego Wrap Vapor Barrier.
    - b. Substitutions: Permitted upon approval of Engineer
    - c. W.R. Meadows Perminator – 15 mil.
    - d. Poly-America Husky Yellow Guard – 15 mil.
- C. Non-Shrink Grout: ASTM C1107/C1107M; premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents; capable of developing minimum compressive strength of 2,400 psi in 48 hours and 7,000 psi in 28 days.

## 2.4 JOINT DEVICES AND FILLER MATERIALS

- A. Joint Filler Type A: ASTM D1751 or ASTM D994; Asphalt impregnated fiberboard or felt, 1/4 inch thick; tongue and groove profile.
- B. Joint Filler Type B: ASTM D1752; recycled PVC.
- C. Joint Filler Type C: ASTM D1752; Premolded sponge rubber.

## 2.5 CONCRETE MIX

- A. Provide concrete to the following criteria for interior concrete:

| Material and Property         | Measurement |
|-------------------------------|-------------|
| Compressive Strength (7 day)  | 3000 psi    |
| Compressive Strength (28 day) | 4000 psi    |

|                              |                                                         |
|------------------------------|---------------------------------------------------------|
| Cement Type                  | ASTM C150                                               |
| Aggregate Type               | Normal weight                                           |
| Min. Cementitious Content    | 564 lb/cu yd                                            |
| Water-Cement Ratio (maximum) | 0.45 by weight                                          |
| Aggregate Size (maximum)     | 3/4 inch                                                |
| Aggregate Size (minimum)     | 1/2 inch                                                |
| Air Content                  | 0 to 3 percent entrapped                                |
| Fly Ash Content:             | 20 percent of cementitious materials by weight, maximum |
| Slump                        | 4 inches plus or minus 1 inch                           |

- B. Provide concrete to the following criteria for concrete exposed to weather:

| Material and Property         | Measurement                                             |
|-------------------------------|---------------------------------------------------------|
| Compressive Strength (7 day)  | 3000 psi                                                |
| Compressive Strength (28 day) | 4000 psi                                                |
| Cement Type                   | ASTM C150                                               |
| Aggregate Type                | Normal weight                                           |
| Min. Cementitious Content     | 564 lb/cu yd                                            |
| Water-Cement Ratio (maximum)  | 0.45 by weight                                          |
| Aggregate Size (maximum)      | 3/4 inch                                                |
| Aggregate Size (minimum)      | 1/2 inch                                                |
| Air Content                   | 6 percent plus or minus 1.5 percent                     |
| Fly Ash Content:              | 20 percent of cementitious materials by weight, maximum |
| Slump                         | 4 inches plus or minus 1 inch                           |

- C. Admixtures: Include admixture types and quantities indicated in concrete mix designs only when approved by Architect/Engineer.

1. Use accelerating admixtures in cold weather. Use of admixtures will not relax cold weather placement requirements.
2. Do not use calcium chloride nor admixtures containing calcium chloride.
3. Use set retarding admixtures during hot weather.
4. Add air entrainment admixture to concrete mix for work exposed to freezing and thawing or deicing chemicals

- D. Average Compressive Strength Reduction: Not permitted.

- E. Ready Mixed Concrete: Mix and deliver concrete in accordance with ASTM C94 and ASTM C685.
- F. Site Mixed Concrete: Mix concrete in accordance with ACI 318.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Verify requirements for concrete cover over reinforcement.
- B. Verify anchors, seats, plates, reinforcement and other items to be cast into concrete are accurately placed, positioned securely, and will not interfere with placing concrete.

#### **3.2 PREPARATION**

- A. Prepare previously placed concrete by cleaning with steel brush and applying bonding agent. Remove laitance, coatings, and unsound materials.
- B. In locations where new concrete is doweled to existing work, drill holes in existing concrete, insert steel dowels and pack solid with non-shrink grout.
- C. Remove debris and ice from formwork, reinforcement, and concrete substrates.
- D. Remove water from areas receiving concrete before concrete is placed.
- E. Concrete can be place under water using tremie as approved by engineer.

#### **3.3 PLACING CONCRETE**

- A. Place concrete in accordance with ACI 301 and ACI 318.
- B. Notify testing laboratory and Engineer minimum 24 hours prior to commencement of operations.
- C. Ensure reinforcement, inserts, embedded parts, formed expansion and contraction joints, and are not disturbed during concrete placement.
- D. Install vapor retarder under interior slabs on grade in accordance with ASTM E1643; place sheets in position with longest dimension parallel with direction of pour.
  - 1. Level and compact base material.
  - 2. Extend vapor barrier to the perimeter of the slab. If practicable, terminate it at the top of the slab, otherwise (a) at a point acceptable to the structural engineer or (b) where obstructed by impediments (such as dowels, water-stops, or any other site condition requiring early termination of the vapor barrier). At the point of termination, seal vapor barrier to the foundation wall, grade beam or slab itself.
  - 3. Lap joints minimum 6 inches and seal watertight by taping edges and ends.
  - 4. Apply seam tape to a clean and dry vapor barrier.
  - 5. Seal all penetrations (including pipes) per manufacturer's instructions.
  - 6. Avoid the use of non-permanent stakes driven through vapor retarder.

7. If non-permanent stakes are driven through vapor retarder, repair as recommended by vapor retarder manufacturer.
  8. Repair vapor retarder damaged during placement of concrete reinforcing. Repair with vapor retarder material of similar (or better) permeance, puncture, and tensile; lap over damaged areas minimum 6 inches and seal watertight.
- E. Separate slabs on grade from vertical surfaces with 1/2 inch thick joint filler unless otherwise shown on drawings.
- F. Deposit concrete at final position. Prevent segregation of mix.
- G. Place concrete in continuous operation for each panel or section determined by predetermined joints.
- H. Consolidate concrete.
- I. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.
- J. Place concrete continuously between predetermined expansion, control, and construction joints.
- K. Do not interrupt successive placement; do not permit cold joints to occur.
- L. Place floor slabs in saw cut pattern indicated.
- M. Saw cut joints within 12 hours after placing. Use 3/16 inch thick blade, cut into 1/4 depth of slab thickness.
- N. Screed floors and slabs on grade level, maintaining surface flatness of maximum 1/8 inch in 10 ft.
- O. In areas with floor drains, maintain floor elevation at walls; pitch surfaces uniformly to drains at 1/8 inch per foot nominal unless otherwise indicated on drawings. Areas that have floor drains shall not be required to meet the levelness tests.

### 3.4 SEPARATE FLOOR TOPPINGS

- A. Prior to placing floor topping, roughen substrate concrete surface and remove deleterious material. Broom and vacuum clean.
- B. Place required reinforcing and other items to be cast in.
- C. Apply bonding agent to substrate.
- D. Place concrete floor toppings to required lines and levels.
- E. Screed toppings level, maintaining surface flatness maximum 1/8 inch in 10 ft.

### 3.5 CONCRETE FINISHING

- A. Provide formed concrete surfaces as follows:

1. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
    - a. Apply to concrete surfaces not exposed to public view.
  2. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
    - a. Apply to concrete surfaces exposed to public view.
  3. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.
- B. Finish concrete floor surfaces in accordance with ACI 301 and ACI 311.
- C. Wood float surfaces receiving quarry tile, ceramic tile or terrazzo with full bed setting system.
- D. Steel trowel surfaces receiving carpeting, resilient flooring, seamless flooring, thin set quarry tile or thin set ceramic tile.
- E. Steel trowel surfaces which are indicated to be exposed.
- 3.6 CURING AND PROTECTION
- A. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
  - B. Protect concrete footings from freezing for minimum 5 days.
  - C. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.
  - D. Cure concrete in accordance with ACI 308.1.
  - E. Cure floor surfaces in accordance with ACI 301 and ACI 318.
- 3.7 FIELD QUALITY CONTROL
- A. Owner shall engage a qualified testing and inspecting agency to perform field special structural inspections and testing in accordance with the applicable International Building Code and to submit reports.
  - B. The contractor shall be responsible for scheduling the tests. The contractor shall be required to notify the owner's representative a minimum of 48 hours prior to all placement of concrete.
  - C. Provide free access to Work and cooperate with appointed firm.

- D. Submit proposed mix design of each class of concrete to inspection and testing firm for review prior to commencement of Work.
- E. Concrete Inspections:
  - 1. Periodic Placement Inspection: Inspect for proper installation procedures.
  - 2. Periodic Curing Inspection: Inspect for specified curing temperature and procedures.
- F. Strength Test Samples:
  - 1. Sampling Procedures: ASTM C172.
  - 2. Cylinder Molding and Curing Procedures: ASTM C31, cylinder specimens, standard cured.
  - 3. Sample concrete and make one set of four cylinders for every 50 cu yds or less of each class of concrete placed each day and for every 5,000 sf of surface area for slabs and walls.
  - 4. When volume of concrete for any class of concrete would provide less than 5 sets of cylinders, take samples from five randomly selected batches, or from every batch when less than 5 batches are used.
  - 5. Make one additional cylinder during cold weather concreting, and field cure.
- G. Field Testing:
  - 1. Slump Test Method: ASTM C143.
  - 2. Air Content Test Method: ASTM C173 for normal weight concrete, ASTM C231 for lightweight concrete.
  - 3. Temperature Test Method: ASTM C1064.
  - 4. Measure slump and temperature for each compressive strength concrete sample.
  - 5. Measure air content in air entrained concrete for each compressive strength concrete sample.
- H. Cylinder Compressive Strength Testing:
  - 1. Test Method: ASTM C39.
  - 2. Test Acceptance: In accordance with ACI 318.
  - 3. Test one cylinder at 7 days.
  - 4. Test two cylinders at 28 days.
  - 5. Retain one cylinder for 56 days for testing when requested by Engineer.
  - 6. Dispose remaining cylinders when testing is not required.
- I. Core Compressive Strength Testing:
  - 1. Sampling and Testing Procedures: ASTM C42.
  - 2. Test Acceptance: In accordance with ACI 318.
  - 3. Drill three cores for each failed strength test from concrete represented by failed strength test.
- J. Maintain records of concrete placement. Record date, location, quantity, air temperature and test samples taken.

### 3.8 PATCHING

- A. Allow Engineer to inspect concrete surfaces immediately upon removal of forms.



- B. Excessive honeycomb or embedded debris in concrete is not acceptable. Notify Engineer upon discovery.
- C. Patch imperfections as directed by Engineer and in accordance with ACI 301 and ACI 318.

### 3.9 DEFECTIVE CONCRETE

- A. Defective Concrete: Concrete not conforming to required lines, details, dimensions, tolerances or specified requirements.
- B. Repair or replacement of defective concrete will be determined by Engineer.
- C. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of Engineer for each individual area.
- D. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or corrective work.

END OF SECTION 033000

**SECTION 034100**  
**PRECAST STRUCTURAL CONCRETE**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. This Section includes the performance criteria, materials, design, production, and erection of structural precast and precast, prestressed concrete for the entire project. The work performed under this Section includes all labor, material, equipment, related services, and supervision required for the manufacture and erection of the structural precast and precast, prestressed concrete work shown on the Contract Drawings.
- B. This Section includes the following:
  - 1. Hollow-core slab units (planks)
- C. Related Sections include the following:
  - 1. Section 033000 "Cast-in-Place Concrete" for installing connection anchors and reinforcing steel in concrete and structural topping.
  - 2. Section 05120 "Structural Steel" for furnishing and installing connections attached to structural-steel framing.
  - 3. Section 05500 "Metal Fabrications" for furnishing and installing loose hardware items.

**1.2 PERFORMANCE REQUIREMENTS**

- A. Structural Performance: Provide structural precast concrete members and connections capable of withstanding design loads indicated within limits and under conditions indicated on Drawings.
  - 1. Design structural precast concrete framing system and connections to maintain clearances at openings, to allow for fabrication and construction tolerances, to accommodate live-load deflection, shrinkage and creep of primary building structure, and other building movements. Maintain structural precast concrete deflections within limits of ACI 318 (ACI 318M).
  - 2. Thermal Movements: Provide for thermal movements noted.
    - a. The precast system design shall consider the maximum seasonal climatic temperature change.
    - b. In plane thermal movements of individual members directly exposed to the sun shall consider a temperature range of 80°.
    - c. Member connection design shall consider through thickness thermal gradients as appropriate.

**1.3 SUBMITTALS**

- A. Product Data: For each type of product indicated. Retain quality control records and certificates of compliance for 5 years after completion of structure.
- B. Design Mixtures: For each precast concrete mixture. Include compressive strength.

C. Shop (Erection) Drawings:

1. Detail fabrication and installation of structural precast concrete units including connections at member ends and to each adjoining member.
2. Indicate locations, plan views, elevations, dimensions, shapes, and cross sections of each unit, openings, support conditions and types of reinforcement, including special reinforcement.
3. Indicate aesthetic intent including joints, rustications or reveals, and extent and location of each surface finish.
4. Indicate welded connections by AWS standard symbols. Show size, length, and type of each weld.
5. Detail loose and cast-in hardware, lifting and erection inserts, connections, and joints.
6. Indicate locations, tolerances and details of anchorage devices to be embedded in or attached to structure or other construction.
7. Include and locate openings larger than 10 in. Where additional structural support is required for openings include header design.
8. Coordinate and indicate openings and inserts required by other trades.
9. Indicate location of each structural precast concrete member by same identification mark placed on unit.
10. Indicate relationship of structural precast concrete members to adjacent materials.
11. Indicate locations and details of joint treatment.
12. Indicate areas receiving toppings and magnitude of topping thickness.
13. Indicate estimated cambers for floor slabs receiving cast-in-place topping.
14. Indicate multiple wythe connection devices.
15. Indicate shim sizes and grouting sequence.
16. Design Modifications: If design modifications are proposed to meet performance requirements and field conditions, notify the Architect and submit design calculations and Shop Drawings. Do not affect the appearance, durability or strength of members when modifying details or materials. Maintain the general design concept when altering size of members and alignment.

D. Provide handling procedures, erection sequences, and for special conditions provide temporary bracing and shoring plan.

E. Comprehensive engineering design signed and sealed by a qualified licensed professional engineer responsible for its preparation licensed in Missouri.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For fabricator and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include list of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

B. Welding Certificates: Copies of certificates for welding procedure specifications (WPS) and personnel certification.

C. Material Test Reports for aggregates: From an accredited testing agency, indicating and interpreting test results for compliance with requirements indicated.

D. Material Certificates: Signed by manufacturers certifying that each of the following items complies with requirements.

1. Cementitious materials.

2. Reinforcing materials and prestressing tendons.
3. Admixtures.
4. Bearing pads.
5. Structural-steel shapes and hollow structural sections.
6. Other components specified in Contract Documents with applicable standards.

## 1.5 QUALITY ASSURANCE

- A. Erector Qualifications: Company specializing in preform work do this section with minimum of 5 years documented experience.
- B. Fabricator Qualifications: A firm that complies with the following requirements and is experienced in producing structural precast concrete units similar to those indicated for this Project and with a record of successful in-service performance.
  1. Assumes responsibility for engineering structural precast concrete units to comply with performance requirements. This responsibility includes preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.
  2. Structural Engineer Qualifications: A professional engineer licensed in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of structural precast concrete that are similar to those indicated for this Project in material, design, and extent.
  3. Participates in PCI's Plant Certification program at the time of bidding and is designated a PCI-certified plant for Group C, Category C1 – Precast Concrete Products (no prestressed reinforcement), C2 – Prestressed Hollow-Core and Repetitive Products, C3 – Prestressed Straight-Strand Structural Members and C4 - Prestressed Deflected-Strand Structural Members.
  4. Has sufficient production capacity to produce required members without delaying the Work.
  5. Certification shall be maintained throughout the production of the precast concrete units. Production shall immediately stop if at any time the fabricator's certification is revoked, regardless of the status of completion of contracted work. Production will not be allowed to re-start until the necessary corrections are made and certification has been re-established. In the event certification(s) can not be re-established in a timely manner, causing project delays, the fabricator, at no additional cost, will contract out the remainder of the units to be manufactured at a PCI certified plant.
- C. Design Standards: Comply with ACI 318 (ACI 318M) and the design recommendations of PCI MNL 120, "PCI Design Handbook – Precast and Prestressed Concrete," applicable to types of structural precast concrete members indicated.
- D. Quality-Control Standard: For manufacturing procedures and testing requirements and quality control recommendations for types of members required, comply with PCI MNL 116, "Manual for Quality Control for Plants and Production of Structural Concrete Products."
  1. Comply with camber and dimensional tolerances of PCI MNL 135, "Tolerance Manual for Precast and Prestressed Concrete Construction."
- E. Product Options: Drawings indicate size, profiles and dimensional requirements of precast concrete members and are based on the specific types of members indicated. Other fabricators' precast concrete members complying with requirements may be considered. Refer to Division 1 Section "Substitutions."

- F. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code – Steel"; AWS D1.4/D1.4M, "Structural Welding Code – Reinforcing Steel"; and AWS D1.6/D1.6M, "Structural Welding Code-Stainless".
- G. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination."

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver all structural precast concrete members in such quantities and at such times to assure compliance with the agreed upon project schedule and setting sequence to ensure continuity of installation.
- B. Handle and transport members in a manner to avoid excessive stresses that could cause cracking or other damage.
- C. Store units with adequate dunnage and bracing, and protect units to prevent contact with soil, staining, and to control cracking, distortion, warping or other physical damage.
- D. Unless otherwise specified or shown on Shop Drawings, store members with dunnage across full width of each bearing point.
- E. Place stored members so identification marks are clearly visible, and units can be inspected.
- F. Place dunnage of even thickness between each member.
- G. Lift and support members only at designated points indicated on the Shop Drawings.

#### 1.7 SEQUENCING

- A. Furnish loose connection hardware and anchorage items to be embedded in or attached to other construction without delaying the Work. Provide locations, setting diagrams, templates, instructions, and directions, as required, for installation.

### PART 2 - PRODUCTS

#### 2.1 FORM MATERIALS

- A. Forms: Rigid, dimensionally stable, nonabsorptive material, warp and buckle free, that will provide precast concrete surfaces within fabrication tolerances indicated; nonreactive with concrete and suitable for producing required surface finishes.
  - 1. Form-Release Agent: Commercially produced form-release agent that will not bond with, stain or affect hardening of precast concrete surfaces and will not impair subsequent surface or joint treatments of precast concrete.

#### 2.2 REINFORCING MATERIALS

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.

- B. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.
- C. Steel Bar Mats: ASTM A 184/A 184M, fabricated from ASTM A 615/A 615M, Grade 60 (Grade 420), ASTM A 706/A 706M, deformed bars, assembled with clips.
- D. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, or ASTM A 1064/A 1064M, fabricated from as-drawn steel wire into flat sheets.
- E. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, or ASTM A 1064/A 1064M, flat sheet.
- F. Supports: Use bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place according to PCI MNL 116.

## 2.3 PRESTRESSING TENDONS

- A. Prestressing Strand: ASTM A 416/A 416M, Grade 250 (Grade 1720) or Grade 270 (Grade 1860), uncoated, 7-wire, low-relaxation strand or ASTM A 886/A 886M, Grade 270 (Grade 1860), indented, 7-wire, low-relaxation strand (including supplement).
- B. Unbonded Post-Tensioning Strand: ASTM A 416/A 416M, Grade 270 (Grade 1860), 7-wire, low-relaxation strand with corrosion inhibitor conforming to ACI 423.7, with polypropylene tendon sheathing. Include anchorage devices.
- C. Prestressing Strand: ASTM A 910/A 910M, Grade 270 (Grade 1860), uncoated, weldless, 2- and 3-wire, low relaxation strand.
- D. Post-Tensioning Bars: ASTM A 722/A 722M, uncoated high strength steel bar.

## 2.4 CONCRETE MATERIALS

- A. Portland Cement: ASTM C 150, Type I or III.
  - 1. For surfaces exposed to view in finished structure, use same type, brand, and mill source throughout the precast concrete production.
- B. Supplementary Cementitious Materials
  - 1. Fly Ash: ASTM C 618, Class C or F with maximum loss on ignition of 3%.
  - 2. Metakaolin: ASTM C 618, Class N.
  - 3. Silica Fume: ASTM C 1240 with optional chemical and physical requirements.
  - 4. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
- C. Normal weight Aggregates: Except as modified by PCI MNL 116, ASTM C 33, with coarse, non-reactive aggregates complying with Class 4M. Stockpile fine and coarse aggregates for each type of exposed finish from a single source (pit or quarry) for Project.
- D. Lightweight Aggregates: Except as modified by PCI MNL 116, ASTM C 330 with absorption less than 11 percent.
- E. Water: Potable; free from deleterious material that may affect color stability, setting, or strength of concrete and complying with chemical limits of PCI MNL 116.

- F. Air Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.
- G. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and to not contain calcium chloride, or more than 0.15 percent chloride ions or other salts by weight of admixture.
  - 1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
  - 2. Retarding Admixture: ASTM C 494/C 494M, Type B.
  - 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
  - 4. Water-Reducing and Accelerating Admixture ASTM C494/C 494M, Type E.
  - 5. High Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
  - 6. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
  - 7. Plasticizing Admixture for Flowable Concrete: ASTM C 1017/C 1017M.
  - 8. Corrosion Inhibiting Admixture: ASTM C 1582/C 1582M

## 2.5 STEEL CONNECTION MATERIALS

- A. Carbon-Steel Shapes and Plates: ASTM A 36/A 36M
- B. Carbon-Steel Headed Studs: ASTM A 108, Grades 1010 through 1020, cold finished, AWS D1.1/D1.1M, Type A or B, with arc shields and with the minimum mechanical properties of PCI MNL 116, Table 3.2.3.
- C. Carbon-Steel Plate: ASTM A 283/A 283M, Grade C.
- D. Malleable Iron Castings: ASTM A 47/A 47M. Grade 32510 or 35028.
- E. Carbon-Steel Castings: ASTM A 27/A 27M, Grade 60-30 (Grade 415-205).
- F. High-Strength, Low-Alloy Structural Steel: ASTM A 572/A 572M
- G. Carbon-Steel Structural Tubing: ASTM A 500/A 500M, Grade B or C.
- H. Wrought Carbon-Steel Bars: ASTM A 675/A 675M, Grade 65 (Grade 450).
- I. Deformed-Steel Wire or Bar Anchors: ASTM A 496 or ASTM A 706/A 706M.
- J. High-Strength Bolts and Nuts: ASTM A193/A193M, Grade B5 or B7, ASTM A 325/ A 325M, or ASTM A 490/ A 490M, Type 1, heavy hex steel structural bolts, heavy hex carbon-steel nuts, (ASTM A 563/A 563M) and hardened carbon-steel washers (ASTM F 436/F 436M).
- K. Shop-Primed Finish: Prepare surfaces of nongalvanized steel items, except those surfaces to be embedded in concrete, according to requirements in SSPC-SP 3 and shop-apply lead- and chromate-free, rust –inhibitive primer, complying with performance requirements in MPI 79 SSPC-Paint 25 according to SSPC-PA 1.

## 2.6 BEARING PADS AND OTHER ACCESSORIES

- A. Provide one of the following bearing pads for structural precast concrete members [as recommended by precast fabricator for application]:

1. Elastomeric Pads: AASHTO M 251, plain, vulcanized, 100 percent polychloroprene (neoprene) elastomer, molded to size or cut from a molded sheet, 50 to 70 Shore A durometer according to ASTM D 2240, minimum tensile strength 2250 psi (15.5 MPa) per ASTM D 412.
  2. Random-Oriented, Fiber-Reinforced Elastomeric Pads: Preformed, randomly oriented synthetic fibers set in elastomer. Surface hardness of 70 to 90 Shore A durometer according to ASTM D2240. Capable of supporting a compressive stress of 3000 psi (20.7 Mpa) with no cracking, splitting or delaminating in the internal portions of the pad.
  3. Cotton-Duck-Fabric-Reinforced Elastomeric Pads: Preformed, horizontally layered cotton-duck fabric bonded to an elastomer. Surface hardness of 80 to 100 Shore A durometer according to ASTM D 2240. Conforming to Division II, Section 18.10.2 of AASHTO LRFD Bridge Design Specifications or Military Specification, MIL-C-882E.
  4. Frictionless Pads: Polytetrafluoroethylene (PTFE), glass-fiber reinforced, bonded to stainless or mild-steel plates, or random-oriented, fiber-reinforced elastomeric pads, of type required for in-service stress.
  5. High-Density Plastic: Multimer, nonleaching, plastic strip capable of supporting loads with no visible overall expansion.
  6. Hardboard: AHA A135.4, Class 1, tempered hardboard strips, smooth on both sides.
- B. Reglets: PVC extrusions. Stainless steel, Type 304 Copper Reglets and flashing are specified in Section 07620 "Sheet Metal Flashing and Trim." felt or fiber filled face opening of slots covered.
- C. Erection Accessories: Provide clips, hangers, high density plastic or steel shims, and other accessories required to install structural precast concrete members.
- D. Welding Electrodes: Comply with AWS standards for steel type and/or alloy being welded.
- 2.7 GROUT MATERIALS
- A. Sand-Cement Grout: Portland cement, ASTM C 150, Type I, and clean, natural sand, ASTM C 144, or ASTM C 404. Mix at ratio of 1 part cement to 2 ½ to 3 parts sand, by volume, with minimum water required for placement and hydration. Water-soluble chloride ion content of grout less than 0.06 percent chloride ion by weight of cement when tested in accordance with ASTM C 1218/C 1218M.
- B. Non-shrink Grout: Premixed, prepackaged ferrous and non-ferrous aggregate shrink-resistant grout containing selected silica sands, portland cement, shrinkage-compensating agents, plasticizing and water-reducing agents, complying with ASTM C 1107, Grade A for drypack and Grades B and C for flowable grout and of consistency suitable for application with a 30-minute working time. Water-soluble chloride ion content of grout less than 0.06 percent chloride ion by weight of cement when tested in accordance with ATM C1218/C1218M.
- C. Epoxy-resin grout: Two-component mineral-filled epoxy-resin: ASTM C 881/C 881M of type, grade, and class to suit requirements.
- 2.8 CONCRETE MIXTURES
- A. Prepare design mixtures for each type of precast concrete required.
1. Limit use of fly ash to 35 percent replacement of portland cement by weight; granulated blast-furnace slag to 50 percent of portland cement by weight; and metakaolin and silica fume to 10 percent of portland cement by weight.



- B. Design mixtures may be prepared by a qualified independent testing agency or by qualified precast plant personnel at structural precast concrete fabricator's option.
- C. Limit water-soluble chloride ions to maximum percentage by weight of cement permitted by ACI 318 (ACI 318M) or PCI MNL 116 when tested in accordance with ASTM C 1218/C 1218M.
- D. Normalweight Concrete Mixtures: Proportion mixtures by either laboratory trial batch or field test data methods according to ACI 211.1, with materials to be used on Project, to provide normalweight concrete with the following properties:
  - 1. Compressive Strength (28 Days): 5000 psi (34.5 Mpa) minimum.
  - 2. Release Strength: as required by design.
  - 3. Maximum Water-Cementitious Materials Ratio: 0.45.
- E. Lightweight Concrete Mixtures: Proportion mixtures by either laboratory trial batch or field test data methods according to ACI 211.2, with materials to be used on Project, to provide lightweight concrete with the following properties:
  - 1. Compressive Strength (28 Days): 5000 psi (34.5 Mpa) minimum.
  - 2. Release Strength: as required by design.
  - 3. Density (Unit Weight): Calculated equilibrium density of 115 lb/ft.<sup>3</sup> (1842 kg/m<sup>3</sup>), plus or minus 5 lb/ft.<sup>3</sup> (80 kg/m<sup>3</sup>) adjusted to plus or minus 3 lb./ft.<sup>3</sup> (48 kg/ m<sup>3</sup>), when tested in accordance with ASTM C 567.
- F. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content complying with PCI MNL 116.
- G. When included in design mixtures, add other admixtures to concrete mixtures according to manufacturer's written instructions.
- H. Concrete Mixture Adjustments: Concrete mixture design adjustments may be proposed if characteristics of materials, Project conditions, weather, test results, or other circumstances warrant.

## 2.9 FORM FABRICATION

- A. Form: Accurately construct forms, mortar tight, of sufficient strength to withstand pressures due to concrete placement and vibration operations and temperature changes, and for prestressing and detensioning operations. Coat contact surfaces of forms with release agent before reinforcement is placed. Avoid contamination of reinforcement and prestressing tendons by release agent.
- B. Maintain forms to provide completed structural precast concrete members of shapes, lines, and dimensions indicated in Contract Documents, within fabrication tolerances specified.
  - 1. Edge and Corner Treatment: Uniformly [chamfered] [radiused] or as built-in on standard forms.

## 2.10 FABRICATION

- A. Cast-in Anchors, Inserts, Plates, Angles, and Other Anchorage Hardware: Fabricate anchorage hardware with sufficient anchorage and embedment to comply with design requirements. Accurately position for attachment of loose hardware and secure in place during precasting

operations. Locate anchorage hardware where it does not affect position of main reinforcement or concrete placement. Do not relocate bearing plates in members unless approved by Architect.

1. Weld headed studs and deformed bar anchors used for anchorage according to AWS D1.1/D1.1M and AWS C5.4, "Recommended Practices for Stud Welding."
- B. Furnish loose hardware items including steel plates, clip angles, seat angles, anchors, dowels, hangers, and other hardware shapes for securing precast concrete members to supporting and adjacent construction.
- C. Cast-in reglets, slots, and other accessories in structural precast concrete members as indicated on Contract Drawings.
- D. Cast-in openings larger than 10 inches in any dimension. Do not drill or cut openings or prestressing strand without Engineer's approval.
- E. Reinforcement: Comply with recommendations in PCI MNL 116 for fabricating, placing, and supporting reinforcement.
  1. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy the bond with concrete. When damage to epoxy coated reinforcing exceeds limits specified in ASTM A 775/A 775M, repair with patching material compatible with coating material and epoxy coat bar ends after cutting.
  2. Accurately position, support, and secure reinforcement against displacement during concrete-placement and consolidation operations. Locate and support reinforcement by plastic tipped or corrosion resistant metal or plastic chairs, runners, bolsters, spacers, hangers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place according to PCI MNL 116.
  3. Place reinforcing steel and prestressing tendons to maintain at least  $\frac{3}{4}$  in. minimum concrete cover. Provide cover requirements in accordance with ACI 318 (ACI 318M) when units are exposed to corrosive environment or severe exposure conditions. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Direct wire tie ends away from finished, exposed concrete surfaces.
  4. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces in accordance with ACI 318 (ACI 318M) and wire tie laps, where required by design. Offset laps of adjoining widths to prevent continuous laps in either direction.
- F. Reinforce structural precast concrete members to resist handling, transportation, and erection stresses, and specified in-place loads, whichever governs.
- G. Prestress tendons for structural precast concrete members by either pretensioning or post-tensioning methods. Comply with PCI MNL 116.
  1. Delay detensioning or post-tensioning of precast prestressed concrete members until concrete has reached its indicated minimum design release compressive strength as established by test cylinders cured under the same conditions as concrete member.
  2. Detension pretensioned tendons either by gradually releasing tensioning jacks or by heat-cutting tendons, using a sequence and pattern to prevent shock or unbalanced loading.
  3. If concrete has been heat cured, detension while concrete is still warm and moist to avoid dimensional changes that may cause cracking or undesirable stresses.

- H. Comply with requirements in PCI MNL 116 and in this Section for measuring, mixing, transporting, and placing concrete. After concrete batching, no additional water may be added.
- I. Place concrete in a continuous operation to prevent cold joints or planes of weakness from forming in precast concrete members.
  - 1. Place backup concrete to ensure bond with face-mixture concrete.
- J. Thoroughly consolidate placed concrete by vibration without dislocating or damaging reinforcement and built-in items, and minimize pour lines, honeycombing or entrapped air voids on surfaces. Use equipment and procedures complying with PCI MNL 116.
  - 1. Place self-consolidating concrete without vibration in accordance with PCI TR-6 "Interim Guidelines for the Use of Self-Consolidating Concrete." If face and backup concrete is used, ensure adequate bond between concrete mixtures.
- K. Comply with PCI MNL 116 procedures for hot and cold-weather concrete placement.
- L. Identify pickup points of precast concrete members and orientation in structure with permanent markings, complying with markings indicated on Shop Drawings. Imprint or permanently mark casting date on each precast concrete member on a surface that will not show in finished structure.
- M. Cure concrete, according to requirements in PCI MNL 116, by moisture retention without heat or by accelerated heat curing using live steam or radiant heat and moisture. Cure members until compressive strength is high enough to ensure that stripping does not have an effect on the performance or appearance of final product.

## 2.11 FABRICATION TOLERANCES

- A. Fabricate structural precast concrete members of shapes, lines and dimensions indicated, so each finished member complies with PCI MNL 135 product tolerances as well as position tolerances for cast-in items.

## 2.12 FINISHES

- A. Commercial (Structural) Finishes
  - 1. Grade B Finish: Fill air pockets and holes larger than 1/4 inch (6 mm) in diameter with sand-cement paste matching color of adjacent surfaces. Fill air holes greater than 1/8 inch (3 mm) in width that occur in high concentration (more than one per 2 in.<sup>2</sup> [1300 mm<sup>2</sup>]). Grind smooth form offsets or fins larger than 1/8 inch (3 mm). Repair surface blemishes due to dents in forms. Discoloration is permitted at form joints.
- B. Screed or float finish unformed surfaces. Strike off and consolidate concrete with vibrating screeds to a uniform finish, float finish, if required. Hand screed at projections. Normal color variations, minor indentations, minor chips, and spalls are permitted. No major imperfections, honeycombing, or defects are permitted.
- C. Smooth steel-trowel finish unformed surfaces. Consolidate concrete, bring to proper level with straightedge, float and trowel to a smooth, uniform finish.

- D. Apply roughened surface finish in accordance with ACI 318 (ACI 318M) to precast concrete members that will receive concrete topping after installation.

## 2.13 SOURCE QUALITY CONTROL

- A. Quality-Control Testing: Test and inspect precast concrete according to PCI MNL 116 requirements. If using self-consolidating concrete also test and inspect according to PCI TR-6 "Interim Guidelines for the Use of Self-Consolidating Concrete" and ASTM C 1611/C 1611M, ASTM C 1712, ASTM 1610/1610M, and ASTM C 1621/C 1621M.
- B. In addition to PCI Certification, **Owner** will employ an independent testing agency to evaluate structural precast concrete fabricator's quality-control and testing methods.
  - 1. Allow Owner's testing agency access to material storage areas, concrete production equipment, concrete placement, and curing facilities. Cooperate with Owner's testing agency and provide samples of materials and concrete mixtures as may be requested for additional testing and evaluation.
- C. Strength of precast concrete members will be considered deficient if units fail to comply with ACI 318 (ACI 318M) concrete strength requirements.
- D. Testing: If there is evidence that strength of precast concrete members may be deficient or may not comply with ACI 318 (ACI 318M) requirements, fabricator shall employ an independent testing agency to obtain, prepare, and test cores drilled from hardened concrete to determine compressive strength according to ASTM C 42/C 42M and ACI 318/ACI 318M.
  - 1. Test results shall be reported in writing on the same day that tests are performed, with copies to Architect, Contractor, and precast concrete fabricator. Test reports shall include the following:
  - 2. Project identification name and number.
  - 3. Date when tests were performed.
  - 4. Name of precast concrete fabricator.
  - 5. Name of concrete testing agency.
  - 6. Identification letter, name, and type of precast concrete member(s) represented by core tests; design compressive strength; type of failure; actual compressive strength at breaks, corrected for length-diameter ratio; and direction of applied load to core in relation to horizontal plane of concrete as placed.
- E. Patching: If core test results are satisfactory and precast concrete members comply with requirements, clean and dampen core holes and solidly fill with precast concrete mixture that has no coarse aggregate, and finish to match adjacent precast concrete surfaces.
- F. Acceptability. Structural precast concrete members that do not comply with acceptability requirements in PCI MNL 116, including concrete strength, and manufacturing tolerances, are unacceptable. Chipped, spalled or cracked members may be repaired. Replace unacceptable units with precast concrete members that comply with requirements.

## **PART 3 - EXECUTION**

### **3.1 PREPARATION**

- A. Furnish loose connection hardware and anchorage devices for precast concrete members to be embedded in or attached to the building structural frame or foundation before starting that Work. Provide locations, setting diagrams, templates and instructions for the proper installation of each anchorage device.

### **3.2 EXAMINATION**

- A. Examine supporting structural frame or foundation and conditions for compliance with requirements for installation tolerances, bearing surface tolerances, and other conditions affecting precast concrete performance.
- B. Proceed with precast concrete installation only after unsatisfactory conditions have been corrected.
- C. Contractor shall notify precast concrete erector that supporting cast-in-place concrete foundation and building structural framing has attained minimum allowable design compressive strength or supporting steel or other structure is structurally ready to receive loads from precast concrete members prior to proceeding with installation.

### **3.3 ERECTION**

- A. Install loose clips, hangers, bearing pads, and other accessories required for connecting structural precast concrete members to supporting members and backup materials.
- B. Erect structural precast concrete level, plumb and square within the specified allowable erection tolerances. Provide temporary structural framing, shoring and bracing as required to maintain position, stability, and alignment of members until permanent connections are completed.
  - 1. Install temporary steel or plastic spacing shims or bearing pads as precast concrete members are being erected. Surface weld steel shims to each other to prevent shims from separating.
  - 2. Maintain horizontal and vertical joint alignment and uniform joint width as erection progresses.
  - 3. Remove projecting lifting devices and use plastic patchcaps or sand-cement grout to fill voids within recessed lifting devices flush with surface of adjacent precast concrete surfaces when recess is exposed.
  - 4. Unless otherwise indicated provide uniform joint widths of  $\frac{3}{4}$  in.
  - 5. For hollow-core slab voids used as electrical raceways or mechanical ducts, align voids between units and tape butt joint at end of slabs.
  - 6. Provide and install headers of structural-steel shapes for openings larger than one slab width according to hollow-core slab fabricator's written recommendations.
- C. Connect structural precast concrete members in position by bolting, welding, grouting, or as otherwise indicated on approved Shop (Erection) Drawings. Remove temporary shims, wedges, and spacers as soon as practical after connecting and/or grouting are completed.
  - 1. Disruption of roof flashing continuity by connections is not permitted; concealment within roof insulation is acceptable.

- D. Welding: Comply with applicable AWS D1.1/D1.1M, AWS D1.4/D1.4M and AWS D1.6/D1.6M requirements for welding, welding electrodes, appearance of welds, quality of welds, and methods used in correcting welding work.
1. Protect structural precast concrete members and bearing pads from damage during field welding or cutting operations and provide noncombustible shields as required.
  2. Welds not specified shall be continuous fillet welds, using not less than the minimum fillet as specified by AWS D1.1/D1.1M, D1.4/D1.4M or D1.6/D1.6M.
  3. Clean-weld-affected metal surfaces with chipping hammer followed by brushing or power tool cleaning and then reprime damaged painted surfaces in accordance with manufacturer's recommendations.
  4. For galvanized metal, clean weld affected metal surfaces with chipping hammer followed by brushing or power tool cleaning, and apply a minimum 0.004 inch (4 mil) thick coat of galvanized repair paint to galvanized surfaces in conformance with ASTM A 780/A 780M.
  5. Visually inspect all welds critical to precast concrete connections. Visually check all welds for completion and remove, reweld or repair all defective welds, if services of AWS-certified welding inspector are not furnished by Owner.
- E. At bolted connections, use upset threads, thread locking compound or other approved means to prevent loosening of nuts after final adjustment.
1. Where slotted connections are used, verify bolt position and tightness at installation. For sliding connections, properly secure bolt but allow bolt to move within connection slot.
  2. For slip critical connections, one of the following methods shall be used to assure proper bolt pretension:
    - a. Turn-of-Nut – in accordance with AISC.
    - b. Calibrated Wrench – in accordance with AISC.
    - c. Twist-off Tension Control Bolt – meeting ASTM F 1852.
    - d. Direct-Tension Control Bolt – meeting ASTM F 1852.
  3. For slip critical connections, the method to be used and the inspection procedure to be used shall be approved by the Architect and coordinated with the inspection agency.
- F. Grouting or Dry-Packing Connections and Joints: Indicate joints to be grouted and any critical grouting sequences on Shop (Erection) Drawings. Grout open spaces at keyways, connections and joints where required or indicated. Provide reinforcing steel where indicated. Retain flowable grout in place until it gains sufficient strength to support itself. Fill joints completely without seepage to other surfaces. Alternatively, pack spaces with stiff dry pack grout material, tamping until voids are completely filled. Place grout and finish smooth, level, and plumb with adjacent concrete surfaces. Promptly remove grout material from exposed surfaces before it affects finishes or hardens. Keep grouted joints damp for at least 24 hours after initial set.
1. Trowel top of grout joints on roofs smooth to prevent any unevenness that might interfere with placing of, or cause damage, to insulation and roofing. Finish transitions due to different surface levels not steeper than 1 to 12.
  2. At Hollow-Core Slab Ends (where shown on Drawings): Provide suitable end cap or dam in voids as required.
- G. Field cutting of precast, prestressed concrete members is not permitted without approval of the Engineer.
- H. Fasteners: Do not use drilled or power-actuated fasteners for attaching accessory items to precast, prestressed concrete members unless approved by Precast Engineer and Engineer of Record.

### 3.4 ERECTION TOLERANCES

- A. Erect structural precast concrete members level, plumb, square, and in alignment without exceeding the noncumulative erection tolerances of PCI MNL 135. Level out variations between adjacent members by jacking, loading, or any other feasible method as recommended by the fabricator and acceptable to the Architect.

### 3.5 FIELD QUALITY CONTROL

- A. **Owner** shall engage a qualified testing and inspecting agency to perform field special structural inspections and testing in accordance with the applicable International Building Code and to submit reports.
  - 1. Erection of loadbearing precast concrete members.
  - 2. Field welds will be subject to visual inspections and may be subject to dye penetrant or magnetic particle testing in accordance with ASTM E 165 or ASTM E 1444. Testing agency shall be qualified in accordance with ASTM E543.
  - 3. Testing agency will report test results promptly and in writing to Contractor and Architect.
- B. Repair or remove and replace work where tests and inspections indicate that it does not comply with specified requirements.
- C. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

### 3.6 REPAIRS

- A. Repairs will be permitted provided structural adequacy, serviceability and durability of members and appearance are not impaired.
- B. Prepare and repair damaged galvanized coatings with galvanizing repair paint according to ASTM A 780/A 780M.
- C. Wire brush, clean, and paint damaged prime-painted components with same type of shop primer.
- D. Remove and replace damaged structural precast concrete members when repairs do not comply with specified requirements.

### 3.7 CLEANING

- A. Clean mortar, plaster, fireproofing, weld slag, and any other deleterious material from concrete surfaces and adjacent materials immediately.
- B. Clean exposed surfaces of precast concrete members after erection and completion of joint treatment to remove weld marks, other markings, dirt, and stains.
  - 1. Perform cleaning procedures, if necessary, according to precast concrete fabricator's recommendations. Protect adjacent work from staining or damage due to cleaning operations.
  - 2. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes or damage adjacent materials.

END OF SECTION 034100



**SECTION 042000**  
**UNIT MASONRY**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. This Section includes unit masonry assemblies consisting of the following:
  - 1. Concrete masonry units (CMUs).
  - 2. Face Brick
- B. Related Sections:
  - 1. See 044300 Cast Stone for precast sills.
- C. Products installed but not furnished in this Section include:
  - 1. See Division 05 Section "Metal Fabrications" for furnishing steel lintels and shelf angles for unit masonry.

**1.2 SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For reinforcing steel. Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement.
- C. Samples for each type and color of exposed masonry units.
- D. Material Certificates: For each type of product indicated. Include statements of material properties indicating compliance with requirements including compliance with standards and type designations within standards.
  - 1. For masonry units include material test reports substantiating compliance with requirements.
- E. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.

**1.3 QUALITY ASSURANCE**

- A. Fire-Resistance Ratings: Where indicated, provide materials and construction identical to those of assemblies with fire-resistance ratings determined per ASTM E 119 by a testing and inspecting agency, by equivalent concrete masonry thickness, or by other means, as acceptable to authorities having jurisdiction.
- B. Sample Panels: Build sample panels to verify selections made under sample submittals and to demonstrate aesthetic effects.

1. Build sample panels for each type of exposed unit masonry construction in sizes approximately 48 inches long by 48 inches high.

#### 1.4 PROJECT CONDITIONS

- A. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
- B. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
- C. Store masonry units above ground on level platforms which allow air circulation under the stacked units.
- D. Cover and protect against wetting prior to use.
- E. All masonry units shall be delivered to mason undamaged. Cracked or broken, block with spalled edges or corner, or otherwise defective block shall be rejected by contractor upon delivery and shall not be used in the work.

### PART 2 - PRODUCTS

#### 2.1 CONCRETE MASONRY UNITS (CMUs)

- A. Shapes: Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions. Provide bullnose units at all exposed outside CMU wall corners.
- B. Integral Water Repellent: Provide units made with liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength for exposed exterior units.
  1. Products:
    - a. Addiment Incorporated; Block Plus W-10.
    - b. Grace Construction Products, a unit of W. R. Grace & Co. - Conn.; Dry-Block.
    - c. Master Builders, Inc.; Rheopel.
- C. Concrete Masonry Units: ASTM C 90 UBC Standard 21-4.
  1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2150 psi.
  2. Weight Classification: Lightweight, Medium Weight, or Normal Weight.

#### 2.2 CONCRETE AND MASONRY LINTELS

- A. Masonry Lintels: Made from bond beam concrete masonry units with reinforcing bars placed as indicated and filled with coarse grout.

## 2.3 BRICK

### A. Manufacturers:

1. Midwest Block & Brick - Glen-Gery; [www.glengery.com](http://www.glengery.com)
2. Architect approved equal

### B. General: Provide colors, textures, and shapes indicated and as follows:

1. Color and Texture: Location of each indicated on drawings.
  - a. BRICK 1: Mink Grey Smooth
  - b. BRICK 2: Attica
2. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
3. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.

### C. Face Brick: ASTM C 216, Grade MW or SW, Type FBS.

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 3000 psi.
2. Initial Rate of Absorption: Less than 30 g/30 sq. in. per minute when tested per ASTM C 67.
3. Efflorescence: Provide brick that has been tested according to ASTM C 67 and is rated "not effloresced."
4. Size (Actual Dimensions): 3-5/8 inches wide by 3-5/8 inches high by 7-5/8 inches long.

## 2.4 MORTAR AND GROUT MATERIALS

### A. Portland cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction.

### B. Hydrated Lime: ASTM C 207 Type S.

### C. Masonry Cement: ASTM C 91.

#### 1. Products:

- a. Capital Materials Corporation; Flamingo Color Masonry Cement.
- b. Essroc, Italcementi Group; Brixment.
- c. Holcim (US) Inc.; Rainbow Mortamix Custom Buff Masonry Cement.

### D. Aggregate for Mortar: ASTM C 144.

1. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.

### E. Aggregate for Grout: ASTM C 404.

- F. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.

1. Products:

- a. Addiment Incorporated; Mortar Kick.
- b. Euclid Chemical Company (The); Accelguard 80.
- c. Grace Construction Products, a unit of W. R. Grace & Co. - Conn.; Morset.
- d. Sonneborn, Div. of ChemRex; Trimix-NCA.

2. Color: Location of each indicated on drawings.

- a. GROUT 1 – Glen-Gery – G501
- b. GROUT 2 – Glen-Gery – G202

- G. Water: Potable.

## 2.5 REINFORCEMENT

- A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60.
- B. Masonry Joint Reinforcement: ASTM A 951; mill galvanized, carbon-steel wire for interior walls and hot-dip galvanized, carbon-steel wire for exterior walls.
- C. Single wythe wall horizontal reinforcing: truss and/or ladder type; plain steel; galvanized finish 3/16 inch side rods with 3/16 inch cross ties.

1. Ladder type reinforcing:

|    | Manufacturer            | Description | Catalog No. |
|----|-------------------------|-------------|-------------|
| a. | AA Wire Products Co.    | Blok-Lok    | AA500       |
| b. | Hohmann & Barnard, Inc. | Ladder-Mesh | #120        |
| c. | Dur-O-Wall, Inc.        | Ladur Type  |             |

2. Truss type reinforcing:

|    | Manufacturer            | Description | Catalog No. |
|----|-------------------------|-------------|-------------|
| a. | AA Wire Products Co.    | Blok-Lok    | AA600       |
| b. | Hohmann & Barnard, Inc. | Truss-Mesh  | #120        |
| c. | Dur-O-Wall, Inc.        | Truss       |             |

- D. Multiple wythe wall horizontal reinforcing:

1. Tri-rod; truss and/or ladder type; plain steel; galvanized finish; 3/16 inch side rods with 3/16 inch cross ties.

a. Ladder Type reinforcing:

|    | Manufacturer     | Description | Catalog No. |
|----|------------------|-------------|-------------|
| 1) | AA Wire Products | Blok-Lok    | AA500       |
|    |                  | Tri-Lok     | AA510       |

- |    |                         |                   |      |
|----|-------------------------|-------------------|------|
| 2) | Hohmann & Barnard, Inc. | Ladder Mesh       | #220 |
|    |                         | Ladder-Tri-Mesh   | #230 |
| 3) | Dur-O-Wall, Inc.        | Ladur Type        |      |
|    |                         | Ladur Type Trirod |      |

b. Truss Type Reinforcing:

|    | Manufacturer            | Description       | Catalog No. |
|----|-------------------------|-------------------|-------------|
| 1) | AA Wire Products Co.    | Blok-Lok          | AA600       |
|    |                         | 3 Wire Blok Truss | AA610       |
| 2) | Hohmann & Barnard, Inc. | Truss Mesh        | #120        |
|    |                         | Truss-Tri-Mesh    | #130        |
| 3) | Dur-O-Wall, Inc.        | Truss             |             |

2. Truss and/or Ladder type reinforcing with U-shaped anchors welded every 16 inches on center and extending into the cavity of the two wythe wall; plain steel; galvanized finish; 3/16 inch side rods with 3/16 inch cross ties and 3/16 inch anchors; complete with 3/16 inch rectangular hooked box tie.

a. Ladder type reinforcing:

|    | Manufacturer                            | Description     | Catalog No. |
|----|-----------------------------------------|-----------------|-------------|
| 1) | AA Wire Products Co.                    | Econo-Lok       | AA550       |
| 2) | Hohmann & Barnard, Inc.                 | Ladder Box Mesh | #260        |
| 3) | Masonry Reinforcing Corp.<br>Of America | Adj. Ladder Tab | WB600       |

b. Truss type reinforcing:

|    | Manufacturer                            | Description      | Catalog No. |
|----|-----------------------------------------|------------------|-------------|
| 1) | AA Wire Products Co.                    | Econo-Blok Truss | AA650       |
| 2) | Hohmann & Barnard, Inc.                 | Truss Box Mesh   | #160        |
| 3) | Masonry Reinforcing Corp.<br>Of America | Adj. Ladder Tab  | WB700       |

E. Cavity backup wall horizontal reinforcing:

1. Truss and/or Ladder type reinforcing with U-shaped extending into the cavity of the two wythe wall; plain steel; hot dip galvanized, after fabrication, finish; 3/16 inch side rods with cross ties and 3/16 inch anchors; complete with 3/16 inch rectangular hooded box tie. The u-shaped anchor shall have a restraint bar and other device attached to it to prevent transverse movement of the two wythes.

a. Ladder type reinforcing:

|    | Manufacturer                            | Description         | Catalog No. |
|----|-----------------------------------------|---------------------|-------------|
| 1) | AA Wire Products Co.                    | Econo-Cavity Lok II | AA580       |
| 2) | Hohmann & Barnard, Inc.                 | Ladder Box Mesh     | #265        |
| 3) | Masonry Reinforcing Corp.<br>Of America | Adj. Ladder Tab     | WB600-C     |

b. Truss type reinforcing:

|    | Manufacturer         | Description             | Catalog No. |
|----|----------------------|-------------------------|-------------|
| 1) | AA Wire Products Co. | Econo-Cavity Blok-Truss | AA680       |

|    |                                         |                 |         |
|----|-----------------------------------------|-----------------|---------|
| 2) | Hohmann & Barnard, Inc.                 | Truss Box Mesh  | #165    |
| 3) | Masonry Reinforcing Corp.<br>Of America | Adj. Ladder Tab | WB700-C |

## 2.6 EMBEDDED FLASHING MATERIALS

- A. Metal Flashing: Provide metal flashing, where flashing is exposed or partly exposed and where indicated, complying with Division 07 Section "Sheet Metal Flashing and Trim."
  1. Metal Drip Edges: Fabricate from 26 gauge stainless steel. Extend at least 3 inches into wall and ½ inch out from wall, with outer edge bent down 30 degrees and hemmed.
  2. Metal Flashing Terminations: Fabricate from 26 gauge stainless steel. Extend at least 3 inches into wall and out to exterior face of wall. At exterior face of wall, bend metal back on itself for ¾ inch and down into joint ¾ inch to form a stop for retaining sealant backer rod.
  3. Metal Expansion-Joint Strips: Fabricate from 26 gauge stainless steel to shapes indicated.
- B. Flexible Flashing: For flashing not exposed to the exterior, use the following, unless otherwise indicated:
  1. Copper-Laminated Flashing: 5-oz./sq. ft. copper sheet bonded with asphalt between 2 layers of glass-fiber cloth.
    - a. Products:
      - 1) AFCO Products Inc.; Copper Fabric.
      - 2) Polytite Manufacturing Corp.; Copper Fabric Flashing.
      - 3) Sandell Manufacturing Co., Inc.; Copper Fabric Flashing.
      - 4) York Manufacturing, Inc.; York Copper Fabric Flashing.
- C. Solder and Sealants for Sheet Metal Flashings: As specified in Division 07 Section "Sheet Metal Flashing and Trim."
- D. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer.

## 2.7 MISCELLANEOUS MASONRY ACCESSORIES

- A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; formulated from neoprene.
- B. Preformed Control-Joint Gaskets: Made from [styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805] [or] and designed to fit standard sash block and to maintain lateral stability in masonry wall.
- C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).
- D. Weep/Vent Products: Use the following, unless otherwise indicated:

1. Mesh Weep/Vent: Free-draining mesh; made from polyethylene strands, full height and width of head joint and depth  $\frac{1}{8}$  inch less than depth of outer wythe; in color selected from manufacturer's standard.

- a. Products:

- 1) Mortar Net USA, Ltd.; Mortar Net Weep Vents.

- E. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.

1. Provide one of the following configurations:

- a. Strips, full-depth of cavity and 10 inches wide, with dovetail shaped notches 7 inches deep.
- b. Strips, not less than  $1\frac{1}{2}$  inches thick and 10 inches wide, with dimpled surface designed to catch mortar droppings and prevent weep holes from being clogged with mortar.
- c. Sheets or strips full depth of cavity and installed to full height of cavity.

2. Products:

- a. Advanced Building Products Inc.; Mortar Break.
- b. Archovations, Inc.; CavClear Masonry Mat.
- c. Dayton Superior Corporation, Dur-O-Wal Division; Polytite MortarStop.
- d. Mortar Net USA, Ltd.; Mortar Net.

- F. FLUID-APPLIED AIR & WATER BARRIER

1. Provide vapor permeable, fluid-applied air and water barriers in cavity walls as detailed on drawings.

2. Acceptable manufacturer's:

- a. Tyvek Fluid Applied WB+, Prosoco R-Guard VB, or approved equal. Install according to manufacturer's recommendations.

## 2.8 INSULATION

- A. Extruded-Polystyrene Board Insulation: ASTM C 578, Type X, closed-cell product extruded with an integral skin.

## 2.9 MASONRY CLEANERS

- A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains from new masonry without damaging masonry. Use product approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.

1. Manufacturers:

- a. Diedrich Technologies, Inc.
- b. EaCo Chem, Inc.

c. ProSoCo, Inc.

## 2.10 MORTAR AND GROUT MIXES

- A. General: Do not use admixtures, unless otherwise indicated.
  - 1. Do not use calcium chloride in mortar or grout.
  - 2. Limit cementitious materials in mortar for exterior and reinforced masonry to portland cement and lime.
  - 3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.
- B. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification.
- C. Mortar for Unit Masonry: Comply with ASTM C 270, Property Specification.
  - 1. For masonry below grade or in contact with earth, use Type M.
  - 2. For reinforced masonry, use Type S.
  - 3. For mortar parge coats, use Type S.
  - 4. For exterior, above-grade, load-bearing and non-load-bearing walls and parapet walls; for interior load-bearing walls; for interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type S.
  - 5. For interior non-load-bearing partitions, Type N may be used instead of Type S.
- D. Grout for Unit Masonry: Comply with ASTM C 476.
  - 1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
  - 2. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143/C 143M.

## PART 3 - EXECUTION

### 3.1 INSTALLATION, GENERAL

- A. Use full-size units without cutting if possible. If cutting is required, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.
- B. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.
- C. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested per ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.
- D. Comply with tolerances in ACI 530.1/ASCE 6/TMS 602 and with the following:



1. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than  $\frac{1}{8}$  inch in 10 feet,  $\frac{1}{4}$  inch in 20 feet, or  $\frac{1}{2}$  inch maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than  $\frac{1}{8}$  inch in 10 feet,  $\frac{1}{4}$  inch in 20 feet, or  $\frac{1}{2}$  inch maximum.

### 3.2 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.
- C. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- D. Fill space between steel frames and masonry solidly with mortar, unless otherwise indicated.
- E. Fill cores in hollow concrete masonry units with grout 24 inches under bearing plates, beams, lintels, posts, and similar items, unless otherwise indicated.

### 3.3 MORTAR BEDDING AND JOINTING

- A. Lay hollow brick and concrete masonry units as follows:
  1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
  2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
  3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
  4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.
- B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.
- C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness, unless otherwise indicated.
- D. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint), unless otherwise indicated.

### 3.4 CAVITY WALLS

- A. Bond wythes of cavity walls together using one of the following methods:

1. Masonry Joint Reinforcement: Installed in horizontal mortar joints.
  - a. Where bed joints of both wythes align, use ladder-type reinforcement extending across both wythes.
  - b. Where bed joints of wythes do not align, use adjustable (two-piece) type reinforcement with continuous horizontal wire in facing wythe attached to ties.
  - c. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable (two-piece) type reinforcement with continuous horizontal wire in facing wythe attached to ties to allow for differential movement regardless of whether bed joints align.
- B. Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Do not attempt to trowel or remove mortar fins protruding into cavity.
- C. Installing Cavity-Wall Insulation: Place small dabs of adhesive, spaced approximately 12 inches o.c. both ways, on inside face of insulation boards, or attach with plastic fasteners designed for this purpose. Fit insulation between wall ties and other confining obstructions, with edges butted tightly. Press units firmly against inside wythe of masonry.
- D. Intersecting and Abutting Walls: Unless vertical expansion or control joints are shown at junction, bond walls together as follows:
  1. Provide individual metal ties not more than 16 inches oc.
  2. Provide continuity with masonry joint reinforcement by using prefabricated T-shaped units.
  3. Provide rigid metal anchors not more than 24 inches oc. If used with hollow masonry units, embed ends in mortar-filled cores.

### 3.5 MASONRY JOINT REINFORCEMENT

- A. General: Install in mortar with a minimum cover of  $\frac{5}{8}$  inch on exterior side of walls,  $\frac{1}{2}$  inch elsewhere. Lap reinforcement a minimum of 6 inches.
- B. Interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.
- C. Provide continuity at wall intersections by using prefabricated T-shaped units.
- D. Provide continuity at corners by using prefabricated L-shaped units.

### 3.6 ANCHORING MASONRY TO STRUCTURAL MEMBERS

- A. Anchor masonry to structural members where masonry abuts or faces structural members to comply with the following:
  1. Provide an open space not less than  $\frac{1}{2}$  inch in width between masonry and structural member, unless otherwise indicated.
  2. Anchor masonry to structural members with anchors embedded in masonry joints and attached to structure, unless otherwise indicated.
  3. Space anchors as indicated, but not more than 24 inches o.c. vertically and 36 inches o.c. horizontally.

### 3.7 FLASHING, WEEP HOLES, CAVITY DRAINAGE, AND VENTS

- A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated. Install vents at shelf angles, ledges, and other obstructions to upward flow of air in cavities, and where indicated.
- B. Install flashing as follows, unless otherwise indicated:
  - 1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing as recommended by flashing manufacturer.
  - 2. At lintels and shelf angles, extend flashing a minimum of 6 inches into masonry at each end. At heads and sills, extend flashing 6 inches at ends and turn up not less than 2 inches to form end dams.
  - 3. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing ½ inch back from outside face of wall and adhere flexible flashing to top of metal drip edge.
  - 4. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing ½ inch back from outside face of wall and adhere flexible flashing to top of metal flashing termination.
- C. Install weep holes in head joints in exterior wythes of first course of masonry immediately above embedded flashing and as follows:
  - 1. Use specified weep/vent products or open head joints to form weeps holes.
  - 2. Space weep holes 24 inches o.c., unless otherwise indicated.
- D. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in Part 2 "Miscellaneous Masonry Accessories" Article.
- E. Install vents in head joints in exterior wythes at spacing indicated. Use specified weep/vent products to form vents.
  - 1. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.

### 3.8 REINFORCED UNIT MASONRY INSTALLATION

- A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
  - 1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
  - 2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other temporary loads that may be placed on them during construction.
- B. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602.
- C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.

1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
2. Limit height of vertical grout pours to not more than 60 inches.

### 3.9 FIELD QUALITY CONTROL

- A. Inspectors: Contractor will engage qualified independent inspectors to perform inspections and prepare reports. Allow inspectors access to scaffolding and work areas, as needed to perform inspections.

1. Perform the following inspections per Section 1705.4, International Building Code 2015.

|    |    |                                                                                                                                           |
|----|----|-------------------------------------------------------------------------------------------------------------------------------------------|
| 1. |    | From the beginning of masonry construction, the following shall be verified to ensure compliance:                                         |
|    | a. | Proportions of site-prepared mortar, grout and prestressing grout for bonded tendons.                                                     |
|    | b. | Placement of masonry units and construction of mortar joints.                                                                             |
|    | c. | Placement of reinforcement, connectors and prestressing tendons and anchorages.                                                           |
|    | d. | Grout space prior to grouting.                                                                                                            |
|    | e. | Placement of grout.                                                                                                                       |
|    | f. | Placement of prestressing grout.                                                                                                          |
| 2. |    | The inspection program shall verify:                                                                                                      |
|    | a. | Size and location of structural elements.                                                                                                 |
|    | b. | Type, size and location of anchors, including other details of anchorage of masonry to structural members, frames or other constructions. |
|    | c. | Specified size, grade and type of reinforcement.                                                                                          |
|    | d. | Welding of reinforcement.                                                                                                                 |
|    | e. | Protection of masonry during cold weather (temperature below 40°F) or hot weather (temperature above 90° F).                              |
|    | f. | Application and measurement of prestressing force.                                                                                        |
| 3. |    | Preparation of any required grout specimens, mortar specimens and/or prisms shall be observed.                                            |
| 4. |    | Compliance with required inspection provisions of the construction documents and the approved submittals shall be verified.               |

- B. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections indicated below and prepare test reports:

1. Payment for these services will be made by Owner from Testing and Inspecting Allowance, as authorized by Change Orders.

- C. Testing Frequency: One set of tests for each 5000 sq. ft. of wall area or portion thereof.
- D. Concrete Masonry Unit Test: For each type of unit provided, per ASTM C 140.
- E. Mortar Test (Property Specification): For each mix provided, per ASTM C 780. Test mortar for mortar air content and compressive strength.
- F. Grout Test (Compressive Strength): For each mix provided, per ASTM C 1019.
- G. Prism Test: For each type of construction provided, per ASTM C 1314, at 7 days and at 28 days.

### 3.10 CLEANING

- A. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
- B. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
  - 1. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes.
  - 2. Protect adjacent surfaces from contact with cleaner.
  - 3. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
  - 4. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
  - 5. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.
  - 6. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

### 3.11 MASONRY WASTE DISPOSAL

- A. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.
  - 1. Do not dispose of masonry waste as fill within 18 inches of finished grade.
  - 2. Remove excess clean masonry waste that cannot be used as fill, as described above, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 042000

**SECTION 044300**  
**CAST STONE**

**PART 1 - GENERAL**

1.1 SECTION INCLUDES

- A. Cast stone masonry.

1.2 RELATED SECTIONS

- A. Section 042000 – Unit Masonry.
- B. Section 079200 – Joint Sealant.

1.3 REFERENCES

- A. ASTM C 150 – Standard Specification for Portland Cement.
- B. ASTM C 1116 – Standard Specification for Fiber-Reinforced Concrete and Shotcrete.
- C. ASTM C 1364 – Standard Specification for Architectural Cast Stone.
- D. Cast Stone Institute Standard Specification ([www.caststone.org](http://www.caststone.org)).

1.4 DEFINITIONS

- A. Cast Stone: Highly refined architectural concrete stone product manufactured to simulate fine grain texture of natural stone.
- B. Vibrant Dry Tamp (VDT) Casting Method: Vibratory ramming of damp, zero-slump concrete against rigid formwork until it is densely compacted and ready for immediate removal from form.
- C. Machine Casting Method: Proprietary automated VDT method which produces modular cladding units in standard sizes with various finishes.

1.5 SUBMITTALS

- A. Comply with Section 013300 – Submittal Procedures.
- B. Product Data: Submit manufacturer's product data.
- C. Shop Drawings: Submit manufacturer's shop drawings including profiles, cross sections, reinforcement, exposed faces, arrangement of joints, anchoring methods, anchors, annotation of components, and their locations in project as indicated on the Drawings.

- D. Shop Tickets: Submit manufacturer's shop tickets including profiles, cross sections, modular unit lengths, reinforcement, exposed faces, and annotation of components proposed for use in project according to cross sections as indicated on the Drawings.
- E. Catalog Cuts: Submit manufacturer's catalog cuts showing page and product numbers of units proposed for use in project.
- F. Verification Samples: Submit pieces of actual cast stone components, 12 inches square, illustrating range of color and texture to be anticipated in components furnished for project.
- G. Test Results: Submit manufacturer's test results of cast stone components made previously by manufacturer using materials from same sources proposed for use in project.

#### 1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A current producer member of Cast Stone Institute, with a minimum of 10 years of experience in producing cast stone of types required for project.
  - 1. Plant shall have adequate capacity to furnish quality, sizes, and quantity of cast stone required without delaying progress of the Work.
  - 2. Products previously produced by plant and exposed to weather shall exhibit satisfactory appearance.
- B. Standards: Unless otherwise specified in this section, cast stone shall comply with the following:
  - 1. ASTM C 1364.
  - 2. Cast Stone Institute Standard Specification.
- C. Mock-ups: Provide full-size cast stone components for installation in mock-up of exterior wall. Approved mock-ups will become standard for appearance and workmanship.
  - 1. Mock-ups shall remain as part of the completed Work.
  - 2. Mock-ups shall not remain as part of the completed Work. At Architect's direction, demolish mock-ups and remove debris.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Delivery:
  - 1. Deliver cast stone components secured to shipping pallets and protected from damage and discoloration.
  - 2. Protect corners from damage.
  - 3. Number each piece individually to match shop drawings and schedules.
- B. Storage:
  - 1. Store cast stone components and installation materials in accordance with manufacturer's instructions.
  - 2. Store cast stone components on pallets with nonstaining, waterproof covers.
  - 3. Ventilate under covers to prevent condensation.
  - 4. Prevent contact with dirt.

- C. Handling: Protect cast stone components during handling and installation to prevent chipping, cracking, or other damage.

## 1.8 SCHEDULING

- A. Schedule and coordinate production and delivery of cast stone components with unit masonry work to optimize on-site inventory and to avoid delaying the Work.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURER

- A. Continental Cast Stone, Website [www.continentalcaststone.com](http://www.continentalcaststone.com), E-Mail [info@continentalcaststone.com](mailto:info@continentalcaststone.com).

### 2.2 CAST STONE MASONRY

- A. Cast Stone:

1. Casting Method: Vibrant dry tamp or machine cast.
2. Compressive Strength: ASTM C 1364.
3. Absorption, Cold Water: ASTM C 1364.
4. Linear Shrinkage: Cast Stone Institute Standard Specification.

- B. Surface Texture: ASTM C 1364.

- C. Color and Finish:

1. Match Color and Texture of Grout-2

- D. Permissible Variation in Color:

1. Total Color Difference: ASTM C 1364, 6 units.
2. Hue Difference: ASTM C 1364, 2 units.

### 2.3 CAST STONE MATERIALS

- A. Portland Cement: ASTM C 150, Type I, white or gray as required to match specified color.
- B. Coarse Aggregate: ASTM C 1364. Granite, quartz, or limestone.
- C. Fine Aggregate: ASTM C 1364. Natural or manufactured sands.
- D. Coloring Pigments: ASTM C 1364. Inorganic iron oxides.
- E. Chemical Admixtures: ASTM C 1364.
- F. Water: Potable.



G. Reinforcement: Where required by ASTM C 1364. Galvanized

H. Fiber Reinforcement: ASTM C 1116, fibrous nylon.

## 2.4 MORTAR MATERIALS

A. Mortar: Cast Stone Institute Standard Specification

## 2.5 ACCESSORIES

A. Anchors: Non-corrosive type, sized for conditions. Hot-dip galvanized steel.

B. Sealants: As specified in Section 079200.

C. Cleaner:

1. Manufacturer's standard-strength, general-purpose cleaner designed for removing mortar and grout stains, efflorescence, and other construction stains from new masonry surfaces without discoloring or damaging masonry surfaces.
2. Approved for intended use by cast stone manufacturer and approved by cleaner manufacturer for use on cast stone and adjacent masonry materials.

## 2.6 FABRICATION

A. Shapes: Unless otherwise indicated on the Drawings, provide:

1. Suitable wash on exterior sills, copings, projecting courses, and components with exposed top surfaces.
2. Drips on projecting components, wherever possible.

B. Reinforcement:

1. As required to withstand handling and structural stresses.
2. Comply with ASTM C 1364.
3. Minimum of 0.25 percent of cross-sectional area of panels which exceed 24 inches in width.
4. Minimum Reinforcing Cover: Twice diameter of reinforcing bars.
5. Units less than 24 inches in either transverse or longitudinal direction may be unreinforced in that direction if structural conditions allow.

C. Curing:

1. Cure cast stone components with a direct-fired steam generator at a minimum temperature of 105 degrees F for a minimum of 6 hours, within 12 hours of fabrication.
2. Cure cast stone components in presence of carbon monoxide and carbon dioxide to promote carbonation at surface, to minimize efflorescence.

D. Finishing: Remove blemishes from exposed surfaces before packaging for shipment.

E. Manufacturing Tolerances: Manufacture cast stone components within tolerances in accordance with Cast Stone Institute Standard Specification.

## 2.7 SOURCE QUALITY CONTROL

- A. Sampling and Testing: ASTM C 1364.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine construction to receive cast stone components. Notify Architect/Engineer if construction is not acceptable. Do not begin installation until unacceptable conditions have been corrected.
- B. Visual Inspection:
  - 1. Visually inspect cast stone components for fit and finish in accordance with ASTM C 1364 before installation.
  - 2. Do not install unacceptable components.

### 3.2 INSTALLATION

- A. General: Install cast stone components in conjunction with masonry, complying with Section 042000.
- B. Setting:
  - 1. Drench cast stone components with clear, running water immediately before installation.
  - 2. Do not use pry bars or other equipment in a manner that could damage cast stone components.
  - 3. Fill dowel holes and anchor slots completely with mortar or non-shrink grout.
  - 4. Set cast stone components in a full bed of mortar, unless otherwise indicated on the Drawings.
  - 5. Fill vertical joints with mortar.
  - 6. Make joints 3/8 inch, unless otherwise indicated on the Drawings.
  - 7. Leave head joints in copings and similar components open for sealant.
  - 8. Rake mortar joints 3/4 inch for pointing.
  - 9. Sponge face of each stone to remove excess mortar.
  - 10. Tuck point joints to a slight concave profile.
- C. Sealant Joints:
  - 1. Comply with Section 079200.
  - 2. Prime ends of cast stone components, insert properly sized foam backing rod, and install required sealant using sealant gun.
  - 3. Provide sealant joints at following locations and as indicated on the Drawings.
    - a. Cast stone components with exposed tops.
    - b. Joints at relieving angles.
    - c. Control and expansion joints.

### 3.3 SETTING TOLERANCES

A. Tolerances: Comply with Cast Stone Institute Standard Specification.

1. Variation from Plumb: Do not exceed 1/8 inch in 5 feet or 1/4 inch in 20 feet or more.
2. Variation from Level: Do not exceed 1/8 inch in 5 feet, 1/4 inch in 20 feet, or 3/8 inch maximum.
3. Variation in Joint Width: Do not vary joint width more than 1/8 inch or 1/4 of nominal joint width, whichever is greater.
4. Variation in Plane Between Adjacent Surfaces: Do not exceed 1/8-inch difference between planes of adjacent components or adjacent surfaces indicated to be flush with components.

### 3.4 REPAIR

A. Surface Repair:

1. Repair chipping and other surface damage noticeable when viewed in direct daylight at 20 feet.
2. Repair with matching touchup material provided by manufacturer and in accordance with manufacturer's instructions.
3. Repair methods and results to be approved by Architect/Engineer.

### 3.5 FIELD QUALITY CONTROL

A. Inspection and Acceptance: Cast Stone Institute Standard Specification.

### 3.6 CLEANING

A. In-Progress Cleaning:

1. Clean cast stone components as work progresses.
2. Remove mortar fins and smears before tooling joints.

B. Final Cleaning:

1. Clean exposed cast stone, after mortar is thoroughly set and cured.
2. Cleaner:
  - a. Wet surfaces with water before applying cleaner.
  - b. Apply cleaner to cast stone in accordance with cleaner manufacturer's instructions.
  - c. Remove cleaner promptly by rinsing thoroughly with clear water.

### 3.7 WATER REPELLANT

A. Apply silane or siloxane water repellant for weatherproofing cast stone in accordance with manufacturer's instructions.

B. Apply water repellant after pointing, repair, cleaning, inspection, and acceptance are completed.

3.8 PROTECTION

- A. Protect cast stone components from splashing and other damage.

END OF SECTION 044300

## **SECTION 051200**

### **STRUCTURAL STEEL FRAMING**

#### **PART 1 - GENERAL**

##### **1.1 SUMMARY**

- A. Section Includes:
  - 1. Structural shapes.
  - 2. Channels and angles.
  - 3. Hollow structural sections.
  - 4. Structural pipe.
  - 5. Structural plates and bars.
  - 6. Bolts, connectors, and anchors.
  - 7. Grout.

##### **1.2 SUBMITTALS**

- A. Shop Drawings: Indicate sizes, spacing, and locations of structural members, openings, connections, cambers, loads, and welded connections.
- B. Manufacturer's Mill Certificate: Certify products meet or exceed specified requirements.
- C. Mill Test Reports: Submit indicating structural strength, destructive and non-destructive test analysis.
- D. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within previous 12 months.

##### **1.3 QUALITY ASSURANCE**

- A. Perform Work in accordance with the following:
  - 1. Structural Steel: AISC 303 and AISC 360.
  - 2. Architecturally Exposed Structural Steel: AISC 303, Section 10.
  - 3. High Strength Bolted Connections: Specifications for Structural Joints Using ASTM A325 or A490 Bolts, prepared by RCSC Committee A.1.

##### **1.4 QUALIFICATIONS**

- A. Fabricator: Company specializing in performing Work of this section with minimum 10 years documented experience.
- B. Erector: Company specializing in performing Work of this section with minimum 5 years documented experience.
- C. Welders and Welding Procedures: AWS D1.1 qualified within previous 12 months.

## **PART 2 - PRODUCTS**

### **2.1 STRUCTURAL STEEL**

- A. Structural W-Shapes: ASTM A992, Grade 50.
- B. Structural M-Shapes: ASTM A36.
- C. Structural S-Shapes: ASTM A36.
- D. Structural T-Shapes: Cut from structural W-shapes.
- E. Channels and Angles: ASTM A36.
- F. Round Hollow Structural Sections: ASTM A500, Grade B.
- G. Square and Rectangular Hollow Structural Sections: ASTM A500, Grade B.
- H. Stainless Steel Square and Rectangular Tubes: ASTM A554, Grade MT-316.
- I. Structural Pipe: ASTM A53, Grade B.
- J. Structural Plates and Bars: ASTM A36.

### **2.2 BOLTS, CONNECTORS, AND ANCHORS**

- A. Bolts: Heavy hex, structural type.
  - 1. ASTM A325; Type 1, hot dipped galvanized.
- B. Nuts: ASTM A563 heavy hex type.
  - 1. Finish: Hot dipped galvanized.
- C. Washers: ASTM F436; Type 1, circular.
  - 1. Finish: Hot dipped galvanized.
- D. Shear Connectors: ASTM A108; Grades 1015 through 1020, headed, unfinished and in accordance with AWS D1.1; Type B.
- E. Anchor Rods: ASTM F1554; Grade 36.
  - 1. Shape: Straight.
- F. Threaded Rods: ASTM A36.
  - 1. Finish: Hot dipped galvanized.

## 2.3 WELDING MATERIALS

- A. Welding Materials: AWS D1.1; type required for materials being welded.

## 2.4 FABRICATION

- A. Continuously seal joined members by continuous welds. Grind exposed welds smooth.
- B. Fabricate connections for bolt, nut, and washer connectors.

## 2.5 FINISHES

- A. Galvanized steel as indicated on drawings.
- B. Structural Steel that is not galvanized shall be cleaned and primed. All exposed structural steel shall be primed and painted per Specification 099100.
- C. Galvanizing for Bolts, Connectors, and Anchors:
  - 1. Hot-Dipped Galvanizing:
    - a. Bolts, Nuts, and Washers: ASTM F2329.
    - b. Connectors and Anchors: ASTM A153/A153M.

## 2.6 ACCESSORIES

- A. Grout: Non-shrink type, pre-mixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing additives, capable of developing minimum compressive strength of 7,000 psi at 28 days.
- B. Shop Primer: SSPC Paint 15, Type 1, red oxide.
- C. Touch-Up Primer: Match shop primer.
- D. Touch-Up Primer for Galvanized Surfaces: SSPC Paint 20 Type II Organic.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Verify bearing surfaces are at correct elevation.
- B. Verify anchors rods are set in correct locations and arrangements with correct exposure for steel attachment.

### 3.2 PREPARATION

- A. Furnish templates for installation of anchor rods and embedments in concrete and masonry work.

### 3.3 ERECTION

- A. Allow for erection loads, and for sufficient temporary bracing to maintain structure safe, plumb, and in alignment until completion of erection and installation of permanent bracing.
- B. Field weld components and shear connectors indicated on Drawings.
- C. Field connect members with threaded fasteners; torque to required resistance, tighten to snug tight for bearing type connections.
- D. Do not field cut or alter structural members without approval of Engineer.
- E. After erection, touch up welds and abrasions to match shop finishes.

### 3.4 GROUT INSTALLATION

- A. Shim bearing plates and equipment supports to proper elevation, snug tighten anchor bolts.
- B. Fill void under bearing surface with grout. Install and pack grout to remove air pockets.
- C. Moist cure grout.
- D. Remove forms after grout is set. Trim grout edges to smooth surface, splayed 45 degrees.
- E. Tighten anchor bolts after grout has cured for a minimum of 3 days.

### 3.5 TOLERANCES

- A. Maximum Variation From Plumb: 1/4 inch per story, non-cumulative.
- B. Maximum Offset From Alignment: 1/4 inch.

### 3.6 FIELD QUALITY CONTROL

- A. **Owner** shall engage a qualified testing and inspecting agency to perform field special structural inspections and testing in accordance with the applicable International Building Code and to submit reports.
- B. Bolted Connections: Inspect in accordance with AISC 303.
  - 1. Visually inspect all bolted connections.
- C. Welding:



1. Certify welders and conduct inspections and tests as required. Record types and locations of defects found in work. Record work required and performed to correct deficiencies.
  2. Visually inspect all welds.
- D. Correct defective bolted connections and welds.
- E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or corrective work.

END OF SECTION 051200

**SECTION 053123**  
**STEEL ROOF DECK**

**PART 1 - GENERAL**

**1.1 SUMMARY**

**A. Section Includes:**

1. Steel roof deck and accessories.
2. Formed steel cant strips, eave strips, and valley strips.
3. Framing for openings up to and including 18 inches.
4. Bearing plates and angles.

**1.2 REFERENCES**

**A. ASTM International:**

1. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
2. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
3. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Baked Hardenable.

**B. American Welding Society:**

1. AWS D1.1 - Structural Welding Code - Steel.

**C. California Department of Health Services:**

1. CA/DHS/EHLB/R-174 - Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers, including 2004 Addenda.

**D. Green Seal:**

1. GC-03[-2nd Edition, January 7, 1997] - Anti-Corrosive Paints.

**E. Steel Deck Institute:**

1. SDI 29 - Design Manual for Composite Decks, Form Decks and Roof Decks.

**F. SSPC: The Society for Protective Coatings:**

1. SSPC Paint 15 - Steel Joist Shop Paint.

**1.3 PERFORMANCE REQUIREMENTS**

- A. Design metal deck in accordance with [SDI 29 Design Manual] [and] [ASCE 3].**

- B. Calculate to structural working stress design and maximum vertical deck deflection of 1/240.

#### 1.4 SUBMITTALS

- A. Shop Drawings: Indicate deck plan, support locations, projections, openings, reinforcement, pertinent details, and accessories.
- B. Product Data: Deck profile characteristics and dimensions, structural properties, and finishes.
- C. Manufacturer's installation instructions.
- D. Manufacturer's Certificates: Certify Products meet or exceed specified requirements.
- E. Field Quality Control Submittals: Contractor furnished special structural inspection reports.
- F. Welders Certificates: Certify welders employed on Work, verifying AWS qualification within previous 12 months.

#### 1.5 QUALIFICATIONS

- A. Welders and Welding Procedures: AWS D1.1 qualified within previous 12 months.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Cut plastic wrap to encourage ventilation.
- B. Store deck on dry wood sleepers; slope for positive drainage.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS

- A. Manufacturers:
  - 1. Vulcraft; Nucor Vulcraft Group
  - 2. Verco Decking, Inc.
  - 3. New Millennium Building Systems, LLC
  - 4. ASC Profiles, Inc
  - 5. Canam United States
  - 6. Epic Metals Corporation
  - 7. Roof Deck, Inc
  - 8. Substitutions: Permitted with approval by Engineer.
- B. Sheet Steel: ASTM A653, Grade 33 Structural Quality; with G60 galvanized coating.
- C. Bearing Plates and Angles: ASTM A36 steel
- D. Welding Materials: AWS D1.1.

## 2.2 ACCESSORIES

- A. Flute Closures: Closed cell foam rubber, 1 inch thick; profiled to fit tight to deck.
- B. Acoustical Insulation: Glass fiber type, minimum 1.1 lb/cu ft density; profiled to suit deck.
- C. Sump Pans, Sump Plates, Valley Strips, and Eave Strips: Fabricated of metal of same type and finish as deck.

## 2.3 FABRICATION

- A. Roof Metal Deck: Type B profile structural roof deck configured as follows:
  - 1. Span Design: multiple.
  - 2. Primed painted by manufacture.
  - 3. Minimum Metal Thicknesses Excluding Finish: As indicated on drawings.
  - 4. Nominal Height: As indicated on drawings.
  - 5. Formed Sheet Width: 36 inches
  - 6. Side Joints: interlocking side laps.
- B. Related Deck Accessories: Metal closure strips, cover plates, cant strips, thickness to match deck thickness, galvanized sheet steel; of profile and size as indicated on drawings.
- C. Roof Sump Pan: Fabricate of 14 gage sheet steel, flat bottom, sloped sides, recessed 1-1/2 inches below roof deck surface, bearing flange 3 inches wide, sealed watertight.
- D. Cant Strips: Formed sheet steel, gage thickness to match deck thickness, 45 degree slope, 3-1/2 inch nominal width and height, flange for attachment.
- E. Fasteners: Galvanized hardened steel, self tapping.
- F. Weld Washers: Mild steel, uncoated, 1 inch outside diameter, 16 gage thick.

## 2.4 FINISHES

- A. Shop prime by manufacture.
- B. All exposed structural steel shall be painted per Specification 099100.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Erect metal deck according to SDI Manual.
- B. Bear deck on masonry, concrete, or wood support surfaces with 4 inch minimum bearing. Align and level.
- C. Bear deck on steel supports with 3 inch minimum bearing. Align and level.

- D. Fasten deck to steel support members at ends and intermediate supports with fusion welds through weld washers or mechanical fasteners at 12 inches o.c. maximum, parallel with deck flute and at transverse flute as indicated on the drawings.
- E. Weld according to AWS D1.1.
- F. Fasten male/female side laps at spacing indicated on the drawings
- G. Reinforce steel deck openings from 6 to 18 inches in size with 2 x 2 x 1/4 inch steel angles. Place framing angles perpendicular to flutes; extend minimum two flutes beyond each side of opening and fusion weld or mechanically attach to deck at each flute.
- H. Install 6 inch minimum wide sheet steel cover plates, of same thickness as deck, where deck changes direction. Fusion weld or mechanically attach at 12 inches o.c. maximum.
- I. Install sheet steel closures and angle flashings to close openings between deck and walls, columns, and openings.
- J. Install single row of foam flute closures above walls and partitions perpendicular to deck flutes.
- K. Position roof sump pans with flange bearing on top surface of deck. Fusion weld at each deck flute.
- L. Place metal cant strips in position and fusion weld or mechanically attach.
- M. Immediately after welding deck and other metal components in position, coat welds, burned areas, and damaged surface coating, with touch-up prime paint.

### 3.2 FIELD QUALITY CONTROL

- A. **Owner** shall engage a qualified inspecting agency to perform field special structural inspections in accordance with the applicable International Building Code and to submit reports.
  - 1. Inspect deck size, gage, location and fastening.
  - 2. Inspect welds according to AWS D1.1.
- B. Provide free access to Work and cooperate with appointed agency.
- C. Correct or replace defective decking and connections.
- D. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or corrective work.

END OF SECTION 053123

## **SECTION 054000 COLD FORMED METAL FRAMING**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. This Section includes the following:
  - 1. Exterior non-load-bearing wall framing.
  - 2. Interior non-load-bearing wall framing.

#### **1.2 SUBMITTALS**

- A. Product Data: For each type of product and accessory indicated.
- B. Shop Drawings:
  - 1. Indicate component details, framed openings, bearing, anchorage, loading, welds, type and location of fasteners, and accessories or items required of related work.
  - 2. Describe method for securing studs to tracks and for welded framing connections.

#### **1.3 QUALITY ASSURANCE**

- A. Product Tests: Mill certificates or data from a qualified independent testing agency indicating steel sheet complies with requirements.
- B. Welding: Qualify procedures and personnel according to AWS D1.3, "Structural Welding Code-Sheet Steel."
- C. Fire-Test-Response Characteristics: Where indicated, provide cold-formed metal framing identical to that of assemblies tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.
- D. AISI Specifications and Standards: Comply with AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members" and its "Standard for Cold-Formed Steel Framing - General Provisions."
  - 1. Comply with AISI's "Standard for Cold-Formed Steel Framing - Header Design."

### **PART 2 - PRODUCTS**

#### **2.1 MATERIALS**

- A. Steel Sheet: ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of grade and coating weight as follows:
  - 1. Grade: As required by structural performance.

2. Coating: G60.

## 2.2 EXTERIOR NON-LOAD-BEARING WALL FRAMING

- A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
  1. Minimum Base-Metal Thickness: 0.0538 inch (16 gage) minimum.
  2. Flange Width: 1½ inches minimum.
  3. Depth: as shown on drawings.
  4. Section Properties: As required by loads.
- B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and same minimum base-metal thickness as steel studs.
- C. Vertical Deflection Clips: Manufacturer's standard head clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.
- D. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal and lateral loads.
- E. Double Deflection Tracks: Manufacturer's double, deep-leg, U-shaped steel tracks, consisting of nested inner and outer tracks; unpunched, with unstiffened flanges.

## 2.3 INTERIOR NON-LOAD-BEARING WALL FRAMING

- A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
  1. Minimum Base-Metal Thickness: 0.0296 inch (22 gage) minimum.
  2. Flange Width: 1¼ inches minimum.
  3. Depth: as shown on drawings.
  4. Spacing: 16 inch on center or as indicated in plans.
  5. Section Properties: As required by loads and indicated in plans.
- B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and same minimum base-metal thickness as steel studs.
- C. Vertical Deflection Clips: Manufacturer's standard head clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.
- D. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal and lateral loads.
- E. Double Deflection Tracks: Manufacturer's double, deep-leg, U-shaped steel tracks, consisting of nested inner and outer tracks; unpunched, with unstiffened flanges.

## 2.4 FRAMING ACCESSORIES

- A. Fabricate steel-framing accessories from steel sheet, ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of same grade and coating weight used for framing members, unless otherwise indicated.
- B. Steel Shapes and Clips: ASTM A 36/A 36M, zinc coated by hot-dip process according to ASTM A 123/A 123M.
- C. Anchor Bolts: ASTM F 1554, Grade 36, threaded carbon-steel headless bolts, with encased end threaded, and carbon-steel nuts; and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A 153/A 153M, Class C.
- D. Expansion Anchors: Fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 5 times design load, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.
- E. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 10 times design load, as determined by testing per ASTM E 1190 conducted by a qualified independent testing agency.
- F. Mechanical Fasteners: ASTM C 1513, corrosion-resistant-coated, self-drilling, self-tapping steel drill screws.
  - 1. Head Type: Low-profile head beneath sheathing, manufacturer's standard elsewhere.

## 2.5 MISCELLANEOUS MATERIALS

- A. Galvanizing Repair Paint: SSPC-Paint 20 or DOD-P-21035.

# PART 3 - EXECUTION

## 3.1 INSTALLATION, GENERAL

- A. Install cold-formed metal framing according to AISI's "Standard for Cold-Formed Steel Framing - General Provisions" and to manufacturer's written instructions unless more stringent requirements are indicated.
- B. Install cold-formed metal framing and accessories plumb, square, and true to line, and with connections securely fastened.
- C. Install framing members in one-piece lengths.
- D. Install temporary bracing and supports to secure framing and support loads comparable in intensity to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.
- E. Do not bridge building expansion and control joints with cold-formed metal framing. Independently frame both sides of joints.



- F. Install insulation, specified in Division 07 Section "Thermal Insulation," in built-up exterior framing members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.
- G. Fasten hole reinforcing plate over web penetrations that exceed size of manufacturer's standard punched openings.
- H. Erection Tolerances: Install cold-formed metal framing level, plumb, and true to line to a maximum allowable tolerance variation of  $\frac{1}{8}$  inch in 10 feet and as follows:
  - 1. Space individual framing members no more than plus or minus  $\frac{1}{8}$  inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

### 3.2 EXTERIOR NON-LOAD-BEARING WALL INSTALLATION

- A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure as indicated.
- B. Fasten both flanges of studs to top and bottom track, unless otherwise indicated. Space studs as follows:
  - 1. Stud Spacing: 16 inches or as indicated.
- C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.
- D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.
  - 1. Install single deflection tracks and anchor to building structure.
  - 2. Install double deflection tracks and anchor outer track to building structure.
  - 3. Connect vertical deflection clips to bypassing studs and anchor to primary building structure.
- E. Install horizontal bridging in wall studs, spaced in rows indicated on Shop Drawings but not more than 48 inches apart. Fasten at each stud intersection.
  - 1. Top Bridging for Single Deflection Track: Install row of horizontal bridging within 12 inches - 18 inches of single deflection track. Install a combination of flat, taut, steel sheet straps of width and thickness indicated and stud or stud-track solid blocking of width and thickness matching studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
    - a. Install solid blocking at centers indicated on Shop Drawings.
  - 2. Bridging: Cold-rolled steel channel welded or mechanically fastened to webs of punched studs.
  - 3. Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
  - 4. Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.

- F. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, fasteners, and stud girts, to provide a complete and stable curtain-wall-framing system.

### 3.3 INTERIOR NON-LOAD-BEARING WALL INSTALLATION

- A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure as indicated.
- B. Fasten both flanges of studs to top and bottom track, unless top track is connected to the roof deck and is non-load bearing. In this case use deep leg deflection track. Do not fasten studs to deflection track. Space studs as follows:
  - 1. Stud Spacing: 16 inches or as indicated.
- C. Set studs plumb, except as needed for diagonal bracing or required for non-plumb walls or warped surfaces and similar requirements.
- D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.
  - 1. Install single deflection tracks and anchor to building structure.
- E. Install horizontal bridging in wall studs, spaced in rows indicated on Shop Drawings but not more than 48 inches apart (unless composite wall with gypsum board installed on both flanges of stud for full height of wall). Fasten at each stud intersection.
  - 1. Top Bridging for Deep Leg Deflection Track: Install row of horizontal bridging within 12 inches of deep leg deflection track.
    - a. Install solid blocking at centers indicated on Shop Drawings.
  - 2. Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.

### 3.4 FIELD QUALITY CONTROL

- A. **Owner** shall engage a qualified testing and inspecting agency to perform field special structural inspections and testing in accordance with the applicable International Building Code and to submit reports.
- B. Field and shop welds will be subject to testing and inspecting.
- C. Testing agency will report test results promptly and in writing to Contractor and Architect.
- D. Remove and replace work where test results indicate that it does not comply with specified requirements.
- E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or corrective work.

3.5 REPAIRS AND PROTECTION

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed metal framing with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and installer, which ensure that cold-formed metal framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION 054000

**SECTION 055000**  
**METAL FABRICATIONS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
1. Shop-fabricated metal items.
  2. Precast connecting plates, angles and accessories.
  3. Structural supports for miscellaneous attachments.
  4. Lintels
  5. Prefinished extruded or plate aluminum framing and supports.

**1.2 SUBMITTALS**

- A. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.
- B. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within previous 12 months.
- C. Field Quality-Control Submittals: Indicate results of Owner-furnished tests and inspections.

**1.3 QUALITY ASSURANCE**

- A. Finish joints according to NOMMA Guideline 1.

**1.4 DELIVERY, STORAGE, AND HANDLING**

- A. Inspection: Accept metal fabrications on-Site in labeled shipments. Inspect for damage.
- B. Protect metal fabrications from damage by exposure to weather or by ground contact.

**1.5 EXISTING CONDITIONS**

- A. Field Measurements: Verify field measurements prior to fabrication. Indicate field measurements on Shop Drawings.

## **PART 2 - PRODUCT**

### **2.1 ANCHORS**

- A. Anchor Rods: ASTM F1554; Grade 36 or Grade 55.
  - 1. Shape: Straight.
  - 2. Furnish with nut and washer; Hot dipped galvanized.
- B. Epoxy Adhesive Anchors:
  - 1. Manufacturer List:
    - a. Hilti HIT-Hy 200 MAX
    - b. Substitutions: Permitted upon approval of Engineer.
  - 2. Grout: According to Section 051200 – Structural Steel Framing: Grout.
  - 3. Threaded Rod: Galvanized.

### **2.2 MATERIALS**

- A. Steel: According to Section 051200 – Structural Steel Framing.
- B. Bolts, Nuts, and Washers for Equipment and Piping:
  - 1. Carbon Steel:
    - a. Structural Connections: ASTM A325, hot-dip galvanized.
    - b. Anchor Bolts: ASTM F1554 Grade 36, hot-dip galvanized.
    - c. Pipe and Equipment Flange Bolts: ASTM A193, Grade B-7.

### **2.3 FABRICATION**

- A. Fit and shop assemble items in largest practical sections for delivery to Site.
- B. Fabricate items with joints tightly fitted and secured.
- C. Continuously seal joined members by continuous welds.
- D. Exposed Welded Joints: NOMMA Guideline 1 Joint Finish.
- E. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.
- F. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.
- G. Fabrication Tolerances:
  - 1. Squareness: 1/8 in maximum difference in diagonal measurements.

2. Maximum Offset between Faces: 1/16 in.
3. Maximum Misalignment of Adjacent Members: 1/16 in.
4. Maximum Bow: 1/8 inch in 48 in.
5. Maximum Deviation from Plane: 1/16 inch in 48 in.

## 2.4 FINISHES

- A. Galvanized steel as indicated on drawings.
- B. Steel that is not galvanized shall be cleaned and primed. All exposed structural steel shall be primed and painted per Specification 099100.
- C. Steel:
  1. Prepare surfaces to be primed according to SSPC SP 2.
  2. Do not prime surfaces in direct contact with concrete or where field welding is required.
  3. Prime paint items with one coat except where galvanizing is specified.
  4. Galvanizing: ASTM A123; hot-dip galvanize after fabrication.
  5. Galvanizing for Fasteners, Connectors, and Anchors: Hot-Dip Galvanizing: ASTM A153.
  6. Bolts: Hot-dip galvanized.
  7. Nuts: Hot-dip galvanized.
  8. Washers: Hot-dip galvanized.
  9. Shop Primer: SSPC Paint 15, Type 1, red oxide.
  10. Touch-Up Primer for Galvanized Surfaces: SSPC Paint 20 Type II Organic.

## PART 4 - EXECUTION

### 4.1 INSTALLATION

- A. Field weld components indicated on Drawings and Shop Drawings. Do not weld exterior units that have been hot-dip galvanized after fabrication.
- B. Obtain approval of Engineer prior to Site cutting or making adjustments not scheduled.

### 4.2 FIELD QUALITY CONTROL

- A. Owner shall engage a qualified testing and inspecting agency to perform field special structural inspections and testing in accordance with the applicable International Building Code and to submit reports.
- B. Inspect welds according to AWS D1.1.
- C. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or corrective work.

END OF SECTION 055000

## **SECTION 055213 PIPE AND TUBE RAILINGS**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. This Section includes the following:
  - 1. Steel pipe and tube railings.

#### **1.2 SUBMITTALS**

- A. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
- B. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

#### **1.3 PERFORMANCE REQUIREMENTS**

- A. Structural Performance: Provide railings capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
  - 1. Handrails:
    - a. Uniform load of 50 lbf/ ft. applied in any direction.
    - b. Concentrated load of 200 lbf applied in any direction.
    - c. Uniform and concentrated loads need not be assumed to act concurrently.
  - 2. Top Rails of Guards:
    - a. Uniform load of 50 lbf/ ft. applied in any direction.
    - b. Concentrated load of 200 lbf applied in any direction.
    - c. Uniform and concentrated loads need not be assumed to act concurrently.
- B. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

### **PART 2 - PRODUCTS**

#### **2.1 MANUFACTURERS**

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Steel Pipe and Tube Railings:

- a. Pisor Industries, Inc.
- b. Sharpe Products.
- c. Wagner, R & B, Inc.; a division of the Wagner Companies.
- d. Substitutions: Permitted with approval by Engineer.

## 2.2 METALS

- A. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails, unless otherwise indicated.
- B. Steel and Iron:
  - 1. Pipe: ASTM A 53/A 53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.
  - 2. Plates, Shapes, and Bars: ASTM A 36/A 36M.
  - 3. Castings: Either gray or malleable iron, unless otherwise indicated.
    - a. Gray Iron: ASTM A 48/A 48M, Class 30, unless another class is indicated or required by structural loads.
    - b. Malleable Iron: ASTM A 47/A 47M.

## 2.3 MISCELLANEOUS MATERIALS

- A. Fasteners: Provide concealed fasteners, unless unavoidable or standard for railings indicated.
  - 1. Steel Railings: Plated steel fasteners complying with ASTM B 633, Class Fe/Zn 25 for electrodeposited zinc coating.
- B. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- C. Shop Primers: Provide primers that comply with Division 09 painting Sections.
- D. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79.

## 2.4 FABRICATION

- A. General: Fabricate railings to comply with design, dimensions, and details indicated, but not less than that required to support structural loads.
- B. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.
- C. Form changes in direction by bending.
- D. Form curves by bending in jigs to produce uniform curvature; maintain cross section of member throughout bend without cracking or otherwise deforming exposed surfaces.
- E. Close exposed ends of railing members with prefabricated end fittings.



- F. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work, unless otherwise indicated.

## 2.5 FINISHES

### A. Steel and Iron:

- 1. Shop-Primed Steel Finish: Prepare to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning" and apply primer to comply with SSPC-PA 1.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive Work.
- B. Verify that concealed blocking and reinforcement are installed and correctly located to receive wall-mounted handrails.

### 3.2 PREPARATION

- A. Clean and strip primed steel items to bare metal where Site welding is required.
- B. Supply items required to be cast into concrete, embedded in masonry and placed in partitions with setting templates to appropriate Sections.

### 3.3 INSTALLATION

- A. General: Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation.
  - 1. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed  $\frac{1}{4}$  inch in 12 feet.
- B. Adjusting and Cleaning:
  - 1. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting.

### 3.4 TOLERANCES

- A. Maximum Variation from Plumb:  $\frac{1}{4}$  inch per story, noncumulative.
- B. Maximum Offset from Alignment:  $\frac{1}{4}$  inch.
- C. Maximum Out-of-Position:  $\frac{1}{4}$  inch.

END OF SECTION 055213

## **SECTION 061000 ROUGH CARPENTRY**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. This Section includes the following:

1. Wood blocking and nailers.
2. Plywood sheathing

#### **1.2 SUBMITTALS**

- A. Product Data: For each type of process and factory-fabricated product.
1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements.
- B. Research/Evaluation Reports: For the following, showing compliance with building code in effect for Project:
1. Wood-preservative-treated wood.

### **PART 2 - PRODUCTS**

#### **2.1 WOOD PRODUCTS, GENERAL**

- A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
1. Factory mark each piece of lumber with grade stamp of grading agency.
  2. Provide dressed lumber, S4S, unless otherwise indicated.

#### **2.2 WOOD-PRESERVATIVE-TREATED LUMBER**

- A. Preservative Treatment by Pressure Process: AWPA C2, except that lumber that is not in contact with the ground and is continuously protected from liquid water may be treated according to AWPA C31 with inorganic boron (SBX)].
1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
- B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent.

- C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
- D. Application: Treat all rough carpentry, unless otherwise indicated:
  - 1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
  - 2. Wood blocking and similar concealed members in contact with masonry or concrete.

## 2.3 MISCELLANEOUS LUMBER

- A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
  - 1. Blocking.
  - 2. Nailers.
- B. For items of dimension lumber size, provide Standard, Stud, or No. 3 grade lumber with 19 percent maximum moisture content of any species.
- C. Plywood Sheathing:
  - 1. Sheathing 5/8" thick. Standard B-C Interior Sheathing with Exterior Glue.

## 2.4 WEATHER RESISTANT BARRIER

- A. ICC AC 38, synthetic house wrap. Refer to place for subsurface to be covered.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry to other construction; scribe and cope as needed for accurate fit. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.
- B. Comply with AWWA M4 for applying field treatment to cut surfaces of preservative-treated lumber.

## 3.2 PROTECTION

- A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 061000

## **SECTION 062000 FINISH CARPENTRY**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

**A. Work includes:**

1. Provide complete, in place, all finish carpentry required for the project, as shown, detailed, scheduled, or noted on the drawings and as specified herein, including:
  - a. Countertop support brackets
  - b. FRP
2. Work under this Section includes all finish carpentry not specifically included in other sections of the work.

**B. Related work**

1. Specified elsewhere
  - a. Rough Carpentry specified in Section 061000.
  - b. Painting and finishing specified in Section 099100.
  - c. Manufactured Wood Casework (including all plastic laminate countertops) specified in Section 123200

#### **1.2 SUBMITTALS**

- A. Product Data: For panel hardware and accessories, and finishing materials and processes.
- B. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.
- C. Samples: All items requiring finish selection.

#### **1.3 PROJECT CONDITIONS**

- A. Environmental Limitations: Do not deliver or install woodwork until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.
- B. Conditioning: Woodwork Manufacturer and Installer shall advise Contractor of temperature and humidity requirements of woodwork installation and storage areas. Do not install woodwork until required temperature and relative humidity have been stabilized and will be maintained in installation areas.
- C. Maintain temperature and humidity in installation area as required to maintain moisture content of installed woodwork within 1.0 percent tolerance of optimum moisture content, from date of

installation through remainder of construction period. Require Woodwork Manufacturer to establish optimum moisture and required temperature and humidity conditions.

- D. Field Measurements: Where woodwork is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
  - 1. Locate concealed framing, blocking, and reinforcement that support woodwork by field measurements before being enclosed, and indicate measurements on Shop Drawings.

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- A. All materials shall be new and as hereinafter specified.

### **2.2 HARDWARE AND ACCESSORIES**

- A. Counter Support Brackets: Provide Richelieu Hardware Workstation Heavy-Duty Brackets with textured powder-coated grey finish.
  - 1. Size to accommodate countertop depth.
- B. Counter Support Cleat: 2"x2"x1/8" Steel Angle Cleat Stock finished to match counter support brackets. Provide by Contractor.

### **2.3 MISCELLANEOUS MATERIALS**

- A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln-dried to less than 15 percent moisture content.
- B. Adhesives, General: Do not use adhesives that contain urea formaldehyde.
- C. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.
- D. FRP Wall Panels: Provide Basis-of-Design "Fiber-lite Liner Panels" #LP-F9 as manufactured by Nudo Products, Inc., Springfield, IL, .090 (embossed/pebbled) textured fire-rated, installed over previously installed gypsum board in locations as shown on drawings. Provide all accessories and vinyl moldings as necessary for a complete installation. Provide trim on inside and outside corners. Do not install battens/trim at every butt seam. Acceptable manufacturers: Crane Composites, Structoglass by Ridout Plastics.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION OF TOPS**

- A. Field Jointing: Where possible make in the same manner as shop jointing, using dowels, splines, adhesives, and fasteners recommended by manufacturer. Prepare edges to be joined in shop so Project-site processing of top and edge surfaces is not required. Locate field joints where shown on Shop Drawings.
- B. Secure backsplashes and end splashes to walls with adhesive.
- C. Seal junctures of tops, splashes, and walls with mildew-resistant silicone sealant or another permanently elastic sealing compound recommended by countertop material manufacturer.

#### **3.2 ADJUSTING AND CLEANING**

- A. Repair damaged and defective finish carpentry, where possible, to eliminate functional and visual defects; where not possible to repair, replace.
- B. Clean, lubricate, and adjust hardware.

END OF SECTION 062000

## **SECTION 072100 THERMAL INSULATION**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. This Section includes the following:
  - 1. Perimeter insulation under slabs-on-grade.
  - 2. Perimeter wall insulation.
  - 3. Cavity-wall insulation.
  - 4. Sound attenuation insulation
  - 5. Vapor retarders.
  - 6. Foamed In-Place Insulation

#### **1.2 SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Samples for Verification: Full-size units for each type of exposed insulation indicated.
- C. Product test reports.
- D. Research/Evaluation Reports: For foam-plastic insulation.

#### **1.3 QUALITY ASSURANCE**

- A. Retain ASTM test method below based on product and kind of fire-resistance characteristic specified for each product in Part 2. Fire-Test-Response Characteristics: Provide insulation and related materials with the fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84 for surface-burning characteristics and other methods indicated with product, by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.

### **PART 2 - PRODUCTS**

#### **2.1 MANUFACTURERS**

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  - 1. Products: Subject to compliance with requirements, provide one of the products specified.
  - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

## 2.2 FOAM-PLASTIC BOARD INSULATION

- A. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV, 1.60 lb/cu. ft., with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively:

1. Available Manufacturers:
  - a. DiversiFoam Products.
  - b. Dow Chemical Company.
  - c. Owens Corning.
  - d. Pactiv Building Products Division.

## 2.3 GLASS-FIBER BLANKET INSULATION

- A. Available Manufacturers:

1. CertainTeed Corporation.
2. Johns Manville.
3. Owens Corning.

- B. Unfaced, Glass-Fiber Blanket Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.

- C. Where glass-fiber blanket insulation is indicated by the following thicknesses, provide blankets in batt or roll form with thermal resistances indicated:

1. 6-1/4 inches thick (R-19) with a thermal resistance of 21 deg F x h x sq. ft./Btu at 75 deg F.

## 2.4 SLAG-WOOL-FIBER/ROCK-WOOL-FIBER BLANKET INSULATION

- A. Manufacturers:

1. Fibrex Insulations Inc.
2. Owens Corning.
3. Thermafiber.

- B. Unfaced, Slag-Wool-Fiber/Rock-Wool-Fiber Blanket Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.

- C. Where slag-wool-fiber/rock-wool-fiber blanket insulation is indicated by the following thicknesses, provide blankets in batt form with thermal resistances indicated:

1. 3-1/2 inches thick with a thermal resistance of 13 deg F x h x sq. ft./Btu at 75 deg F.

## 2.5 VAPOR RETARDERS

- A. Vapor barrier shall have all of the following qualities:



1. Maintain permeance of less than 0.03 Perms [grains/(ft<sup>2</sup> - hr - inHg)] as tested in accordance with mandatory conditioning test per ASTM eq745 Section 7.1 (7.1.1-7.1.5)
2. Other performance criteria:
  - a. Strength: ASTM E1745 Class A.
  - b. Thickness: 10 mils minimum
3. Provide third party documentation that all testing was performed on a single production roll per ASTM E1745 Section 8.1

B. Vapor barrier products:

1. Basis-Of-Design: Stego Wrap Class A Vapor Retarder (10-mil) by Stego Industries LLC., (877) 464-7834 [www.stegoindustries.com](http://www.stegoindustries.com), or comparable product by one of the following:
  - a. Raven Industries Inc., DURA – SKRIM.
  - b. Reef Industries Inc., Griffolyn.

C. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.

D. Vapor-Retarder Fasteners: Pancake-head, self-tapping steel drill screws; with fender washers.

E. Single-Component Nonsag Urethane Sealant: ASTM C 920, Type I, Grade NS, Class 25, Use NT related to exposure, and Use O related to vapor-barrier-related substrates.

F. Adhesive for Vapor Retarders: Product recommended by vapor-retarder manufacturer and with demonstrated capability to bond vapor retarders securely to substrates indicated.

## 2.6 FOAMED IN-PLACE INSULATION

A. Basis-Of-Design: Fomo Products “Hando-Foam” two component low pressure E84 Class 1 spray foam or comparable product by one of the following:

1. Dow Chemical
2. Certainteed

B. Materials - spray foam two-component spray cellular plastic foam complying with the following methods and meeting the following physical properties:

1. Core Density: Minimum 2pcf
2. Thermal Resistance: 140 degree F/ 90 day aged R-Value, measured at 75F mean temp. Minimum R 6.0 per inch.
3. Flame Spread: ASTM E84, Class A – 20.
4. Smoke Developed (ASTM E84, Class A) – 400.
5. Compressed strength minimum (ASTM 1621 D2842: 2.5 percent: perpendicular @ 10% - 16 lb/in<sup>2</sup>; parallel @ 10% - 26 lb/in<sup>2</sup>.
6. Closed Cell Content (ASTM D2856): minimum 95 percent
7. Water absorption by volume maximum (ASTM D2842): 2.9 percent.
8. Water Absorption (ASTM D2842) – 2.9%
9. Fungi Resistance (ASTM G21) – No Growth

- B. Primers: follow manufacturer's recommendations for surface conditions. For oily surfaces like roof deck, aluminum tube or Z-bar, etching or a primer may be needed before spraying polyurethane foam.

## 2.7 AUXILIARY INSULATING MATERIALS

- A. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by insulation manufacturers for sealing joints and penetrations in vapor-retarder facings.
- B. Adhesive for Bonding Insulation: Product with demonstrated capability to bond insulation securely to substrates indicated without damaging insulation and substrates.

## 2.8 INSULATION FASTENERS

- A. Adhesively Attached, Spindle-Type Anchors: Plate formed from perforated galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square, welded to projecting copper-coated steel spindle 0.105 inch in diameter and of length capable of holding insulation of thickness indicated securely in position with 1-1/2-inch- square or diameter self-locking washers complying with the following requirements:
  - 1. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick galvanized steel sheet, with beveled edge for increased stiffness.
- B. Anchor Adhesive: Product with demonstrated capability to bond insulation anchors securely to substrates indicated without damaging insulation, fasteners, and substrates.

# PART 3 - EXECUTION

## 3.1 INSTALLATION, GENERAL

- A. Comply with insulation manufacturer's written instructions applicable to products and application indicated.
- B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed at any time to ice, rain, and snow.
- C. Extend insulation in thickness indicated to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- D. Water-Piping Coordination: If water piping is located within insulated exterior walls, coordinate location of piping to ensure that it is placed on warm side of insulation and insulation encapsulates piping.
- E. For preformed insulating units, provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

### 3.2 INSTALLATION OF PERIMETER AND UNDER-SLAB INSULATION

- A. On vertical surfaces, set insulation units in adhesive applied according to manufacturer's written instructions. Use adhesive recommended by insulation manufacturer.
  - 1. If not otherwise indicated, extend insulation a minimum of 24 inches below exterior grade line.
- B. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.
- C. Protect below-grade insulation on vertical surfaces from damage during backfilling by applying protection course with joints butted. Set in adhesive according to insulation manufacturer's written instructions.
- D. Protect top surface of horizontal insulation from damage during concrete work by applying protection course with joints butted.

### 3.3 INSTALLATION OF GENERAL BUILDING INSULATION

- A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.
- B. Seal joints between foam-plastic insulation units by applying adhesive, mastic, or sealant to edges of each unit to form a tight seal as units are shoved into place. Fill voids in completed installation with adhesive, mastic, or sealant as recommended by insulation manufacturer.
- C. Install board insulation on concrete substrates by adhesively attached, spindle-type insulation anchors as follows:
  - 1. Fasten insulation anchors to concrete substrates with insulation anchor adhesive according to anchor manufacturer's written instructions. Space anchors according to insulation manufacturer's written instructions for insulation type, thickness, and application indicated.
  - 2. After adhesive has dried, install board insulation by pressing insulation into position over spindles and securing it tightly in place with insulation-retaining washers, taking care not to compress insulation below indicated thickness.
  - 3. Where insulation will not be covered by other building materials, apply capped washers to tips of spindles.

### 3.4 INSTALLATION OF VAPOR RETARDERS

- A. General: Extend vapor retarder to extremities of areas to be protected from vapor transmission. Secure in place with adhesives or other anchorage system as indicated.
- B. Seal joints caused by pipes, conduits, electrical boxes, and similar items penetrating vapor retarders with vapor-retarder tape to create an airtight seal between penetrating objects and vapor retarder.
- C. Repair tears or punctures in vapor retarders immediately before concealment by other work. Cover with vapor-retarder tape or another layer of vapor retarder.

### 3.5 INSTALLATION OF FOAMED IN-PLACE INSULATION

#### A. Examination

1. Verify existing conditions are ready to receive work.
2. Beginning of application implies acceptance of existing conditions.

#### B. Preparation

1. Apply required primers for special conditions as recommended by manufacturer.

#### C. Application

1. Apply in accordance with ASTM C1029 and manufacturer's installation guidelines.

END OF SECTION 072100

**SECTION 075323**  
**ETHYLENE-PROPYLENE-DIENE-MONOMER (EPDM) ROOFING**

**PART 1 - GENERAL**

**1.1 SUMMARY**

A. This Section includes the following:

1. Adhered membrane roofing system.
2. Roof system accessories
3. Roof insulation.
4. Metal fascia

B. Related Sections include the following:

1. Division 06 Section "Rough Carpentry" for wood nailers and blocking.
2. Division 07 Section "Roof Specialties" for roof edge drainage systems.
3. Division 07 Section "Joint Sealants."

**1.2 SUBMITTALS**

A. Product Data: For each type of product indicated.

B. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other Work.

1. Base flashings and membrane terminations.
2. Insulation fasteners and fastening patterns.

C. Samples for Verification: For the following products:

1. 12-by-12-inch square of sheet roofing, of color specified, including T-shaped side and end lap seam.
2. 12-by-12-inch square of roof insulation.
3. 12-inch length of metal termination bars.
4. Six insulation fasteners of each type, length, and finish.

D. Installer Certificates: Signed by roofing system manufacturer certifying that Installer is approved, authorized, or licensed by manufacturer to install roofing system.

E. Manufacturer Certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.

1. Submit evidence of meeting performance requirements.

F. Qualification Data: For Installer and manufacturer.

G. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for components of roofing system.

- H. Research/Evaluation Reports: For components of membrane roofing system.
- I. Maintenance Data: For roofing system to include in maintenance manuals.
- J. Warranties: Special warranties specified in this Section.
- K. Inspection Report: Copy of roofing system manufacturer's inspection report of completed roofing installation.

### 1.3 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.4 DEFINITIONS

- A. Roofing Terminology: Refer to ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" for definition of terms related to roofing work in this Section.

### 1.5 PERFORMANCE REQUIREMENTS

- A. General: Provide installed roofing membrane and base flashings that remain watertight; do not permit the passage of water; and resist specified uplift pressures, thermally induced movement, and exposure to weather without failure.
- B. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by roofing membrane manufacturer based on testing and field experience.

### 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's warranty.
- B. Manufacturer Qualifications: A qualified manufacturer that has UL listing for membrane roofing system identical to that used for this Project.
- C. Testing Agency Qualifications: An independent testing agency with the experience and capability to conduct the testing indicated, as documented according to ASTM E 548.
- D. Source Limitations: Obtain components for membrane roofing system from same manufacturer as roofing membrane.

### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, and directions for storing and mixing with other components.

- B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
  - 1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
- C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
- D. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

## 1.8 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

## 1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form, without monetary limitation, in which manufacturer agrees to repair or replace components of membrane roofing system that fail in materials or workmanship within specified warranty period. Failure includes roof leaks.
  - 1. Special total system warranty with no dollar limitation includes roofing membrane, base flashings, roofing system, accessories, roof insulation, fasteners, substrate board, roof pavers, walkway products, coping system, fascia system and other components of membrane roofing system (including all components specified in this section). Unless otherwise approved by the membrane manufacturer, all products must be manufactured and supplied by the roofing system manufacturer and covered by the warranty.
  - 2. Warranty Period: 20 years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

### 2.2 EPDM ROOFING MEMBRANE

- A. EPDM Roofing Membrane: ASTM D 4637, Type I, nonreinforced uniform, flexible sheet made from EPDM, and as follows:

1. Manufacturers:
  - a. Carlisle SynTec Incorporated.
  - b. Firestone Building Products Company.
  - c. Versico Inc.
2. Thickness: 60 mils, nominal.
3. Exposed Face Color: Grey.

## 2.3 AUXILIARY MATERIALS

- A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with membrane roofing.
  1. Liquid-type auxiliary materials shall meet VOC limits of authorities having jurisdiction.
- B. Sheet Flashing: 60-mil- thick EPDM, partially cured or cured, according to application.
- C. Bonding Adhesive: Manufacturer's standard bonding adhesive.
- D. Cold Fluid-Applied Membrane Adhesive: Manufacturer's standard cold fluid-applied bonding adhesive formulated to adhere fleece-backed roofing membrane to substrate.
- E. Seaming Material: Single-component butyl splicing adhesive and splice cleaner.
- F. Lap Sealant: Manufacturer's standard single-component sealant, color to match roofing membrane.
- G. Water Cutoff Mastic: Manufacturer's standard butyl mastic sealant.
- H. Metal Termination Bars: Manufacturer's standard predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch thick; with anchors.
- I. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, in-seam sealants, termination reglets, cover strips, and other accessories.

## 2.4 ROOF INSULATION

- A. General: Provide preformed roof insulation boards that comply with requirements and referenced standards, selected from manufacturer's standard sizes and of thicknesses indicated.
- B. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, felt or glass-fiber mat facer on both major surfaces.
  1. Manufacturers:
    - a. Carlisle SynTec Incorporated.
    - b. Firestone Building Products Company.
    - c. Versico



- C. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches, unless otherwise indicated.
- D. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

## 2.5 INSULATION ACCESSORIES

- A. General: Furnish roof insulation accessories recommended by insulation manufacturer for intended use and compatible with membrane roofing.
- B. Cold Fluid-Applied Adhesive: Manufacturer's standard cold fluid-applied adhesive formulated to adhere roof insulation to substrate.

## 2.6 MANUFACTURED METAL FASCIA SYSTEM

- A. Basis-of-Design Product: Metal-Era "Anchor-tite" fascia or a comparable product by one of the following manufacturers:
  - 1. Hickman, W.P. Company.
  - 2. MM System.
- B. Roof Edging System:
  - 1. Anchor-Tite: Decorative metal fascia with continuous extruded aluminum bar. To terminate adhered or mechanically attached single-ply roofing at perimeter. The system shall be watertight with no exposed fasteners. Model shall be AF-7. The rise above the roof surface for all models is 1-1/4". Fascia model number denotes inches; (i.e. AF-55 has a 5-1/2" face height).
  - 2. Performance Characteristics:
    - a. Extruded bar shall lock membrane, prevent wind pullback.
    - b. Injection molded EPDM splices to allow thermal expansion of extruded aluminum anchor bar.
    - c. Fascia shall freely thermal cycle on extruded bar, preventing periodic maintenance.
    - d. Fascia may be factory modified for true radius application.
  - 3. Fascia metal gauge: .040" thick formed aluminum with Kynar 500 finish.
  - 4. Fascia: standard 12'0" lengths.
  - 5. Extruded bar: Shall be continuous 6063-T6 alloy aluminum at 12'0" standard lengths. All bar miters are welded.
  - 6. Fasteners: #12 x 1 5/8" corrosion resistant fasteners provided with drivers. No exposed fasteners permitted.
  - 7. Exterior fascia finishes: Kynar 500 Shield Bronze UC131645XL.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with the following requirements and other conditions affecting performance of roofing system:
  - 1. Verify that roof openings and penetrations are in place and set and braced and that roof drains are securely clamped in place.
  - 2. Verify that wood blocking and nailers are securely anchored to roof deck at penetrations and terminations and those nailers match thicknesses of insulation.
  - 3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Division 05 Section "Steel Decking."
  - 4. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

- A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.
- B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.
- C. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

### **3.3 INSULATION INSTALLATION**

- A. Coordinate installing membrane roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.
- B. Comply with membrane roofing system manufacturer's written instructions for installing roof insulation.
- C. Install tapered insulation under area of roofing to conform to slopes indicated.
- D. Install one or more layers of insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2 inches or greater, install 2 or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches in each direction.
- E. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.
- F. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch with insulation.
  - 1. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.

G. Adhered Insulation: Install each layer of insulation and adhere to substrate as follows:

1. Prime surface of concrete deck with asphalt primer at rate of 3/4 gal./100 sq. ft. and allow primer to dry.

### 3.4 ADHERED ROOFING MEMBRANE INSTALLATION

- A. Install roofing membrane over area to receive roofing according to membrane roofing system manufacturer's written instructions. Unroll roofing membrane and allow to relax before installing.
- B. Start installation of roofing membrane in presence of membrane roofing system manufacturer's technical personnel.
- C. Accurately align roofing membrane and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
- D. Bonding Adhesive: Apply bonding adhesive to substrate and underside of roofing membrane at rate required by manufacturer and allow to partially dry before installing roofing membrane. Do not apply bonding adhesive to splice area of roofing membrane.
- E. Cold Fluid-Applied Adhesive: Apply cold fluid-applied adhesive to substrate at rate required by manufacturer and install fleece-backed roofing membrane.
- F. Mechanically or adhesively fasten roofing membrane securely at terminations, penetrations, and perimeter of roofing.
- G. Apply roofing membrane with side laps shingled with slope of roof deck where possible.
- H. Adhesive Seam Installation: Clean both faces of splice areas, apply splicing cement, and firmly roll side and end laps of overlapping roofing membranes according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of roofing membrane terminations.
  1. Apply a continuous bead of in-seam sealant before closing splice if required by membrane roofing system manufacturer.
- I. Repair tears, voids, and lapped seams in roofing that does not meet requirements.
- J. Spread sealant or mastic bed over deck drain flange at deck drains and securely seal roofing membrane in place with clamping ring.
- K. Install roofing membrane and auxiliary materials to tie in to existing roofing.

### 3.5 BASE FLASHING INSTALLATION

- A. Install sheet flashings and preformed flashing accessories and adhere to substrates according to membrane roofing system manufacturer's written instructions.
- B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate and allow to partially dry. Do not apply bonding adhesive to seam area of flashing.

- C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.
- D. Clean splice areas, apply splicing cement, and firmly roll side and end laps of overlapping sheets to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of sheet flashing terminations.
- E. Terminate and seal top of sheet flashings [and mechanically anchor to substrate through termination bars.

### 3.6 WALKWAY INSTALLATION

- A. Flexible Walkways: Install walkway products in locations indicated. Adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

### 3.7 FIELD QUALITY CONTROL

- A. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion and submit report to Architect.
  - 1. Notify Architect or Owner 48 hours in advance of date and time of inspection.
- B. Repair or remove and replace components of membrane roofing system where test results or inspections indicate that they do not comply with specified requirements.
- C. Additional inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

### 3.8 PROTECTING AND CLEANING

- A. Protect membrane roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.
- B. Correct deficiencies in or remove membrane roofing system that does not comply with requirements, repair substrates and repair or reinstall membrane roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.
- C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 075323

**SECTION 076200**  
**SHEET METAL FLASHING AND TRIM**

**PART 1 - GENERAL**

1.1 SUMMARY

- A. Section includes
  - 1. Manufactured reglet and counterflashing.
  - 2. Gutters and Downspouts at EPDM roofing

1.2 RELATED SECTIONS

- A. Section 075323 Ethylene Propylene Diene Monomer (EPDM) Roofing

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show installation layouts of sheet metal flashing and trim, including plans, elevations, expansion-joint locations, and keyed details. Distinguish between shop- and field- assembled work.
  - 1. Include details for forming, joining, supporting, and securing sheet metal flashing and trim, including pattern of seams, termination points, fixed points, expansion joints, expansion-joint covers, edge conditions, special conditions, and connections to adjoining work.
- C. Samples: For each exposed product and for each finish specified.
- D. Maintenance data.
- E. Warranty: Sample of special warranty

1.4 QUALITY ASSURANCE

- A. Sheet Metal Flashing and Trim Standard: Comply with SMACNA's "Architectural Sheet Metal Manual" unless more stringent requirements are specified or shown on Drawings.
- B. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
- C. Preinstallation Conference: Conduct conference at Project site

## 1.5 WARRANTY

- A. Special Warranty on Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within 30 years from date of Substantial Completion.

## PART 1 – PRODUCTS

### 2.1 SHEET METALS

- A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying a strippable, temporary protective film before shipping.
- B. Aluminum Sheet: ASTM B 209, alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance required. Refer to drawings for thickness required.
  - 1. Exposed Coil-Coated Finishes:
  - 2. Two-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat.
  - 3. Color: Shield Bronze UC131645XL

### 2.2 MANUFACTURED REGLET / COUNTER FLASHING

- A. Basis of Design: "Metal-Era" surface mounted two-piece counterflashing, 24 ga. Steel, "Kynar 500" factory applied finish Color: Shield Bronze UC131645XL"

### 2.3 ROOF EDGE DRAINAGE SYSTEMS

- A. Basis-of-Design Product: Metal-Era "Seal-tite" Gutter or a comparable product by one of the following:
  - 1. Manufacturers:
    - a. MM Systems.
    - b. Hickman, W. P. Company.
- B. Gutters and Downspouts: Manufactured formed gutter in uniform section lengths not exceeding 12 feet, with mitered and welded corner units, end caps, outlet tubes, and other accessories. Elevate back edge at least 1 inch above front gutter rim. Furnish with flat-stock gutter straps and gutter support brackets and expansion joints and expansion-joint covers fabricated from same metal as gutters.
  - 1. Fabricate gutter from the following exposed metal:
    - a. 24 gauge galvanized steel with Kynar 500 finish Color: Shield Bronze UC131645XL
  - 2. Gutter Style: Comparable to Metal-Era IG-1.
  - 3. Gutter Accessories: continuous removable leaf screen with sheet metal frame.

4. Downspouts: Rectangular closed-face with mitered elbows, manufactured from the following exposed metal. Furnish wall brackets, from same material and finish as downspouts, with anchors.

## 2.4 MISCELLANEOUS MATERIALS

- A. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.
  1. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.
    - a. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
      - 1) Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating.
      - 2) Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.
    - b. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
  2. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.
  3. Elastomeric Sealant: ASTM C 920, elastomeric polymer sealant; low modulus; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
  4. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.
  5. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.

## 2.5 FABRICATION, GENERAL

- A. All gutters, downspouts, counterflashings, soffit panels, thru-wall scuppers and conductor heads shall be pre-manufactured items – NO EXCEPTIONS.
  1. General: Custom fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, geometry, metal thickness, and other characteristics of item indicated. Fabricate items at the shop to greatest extent possible.
    - a. Obtain field measurements for accurate fit before shop fabrication.
    - b. Form sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.
    - c. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces exposed to view.

2. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant.
3. Expansion Provisions: Where lapped expansion provisions cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.
4. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
5. Seams: Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.
6. Seams: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Rivet joints where necessary for strength.

## **PART 3 – EXECUTION**

### **3.1 INSTALLATION, GENERAL**

- A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement so that completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight. Use fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
  1. Install sheet metal flashing and trim true to line and levels indicated. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
  2. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
  3. Space cleats not more than 12 inches apart. Anchor each cleat with two fasteners. Bend tabs over fasteners.
  4. Install exposed sheet metal flashing and trim without excessive oil canning, buckling, and tool marks.
  5. Install sealant tape where indicated.
  6. Torch cutting of sheet metal flashing and trim is not permitted.
- B. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by SMACNA.
  1. Coat back side of uncoated aluminum and stainless-steel sheet metal flashing and trim with bituminous coating where flashing and trim will contact wood, ferrous metal, or cementitious construction.
  2. Underlayment: Where installing metal flashing directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet or install a course of polyethylene sheet.
- C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently watertight, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with sealant concealed within joints.



- D. Fastener Sizes: Use fasteners of sizes that will penetrate wood not less than 3/4 inch for wood screws and metal decking not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.
- E. Seal joints as shown and as required for watertight construction.
- F. Rivets: Rivet joints in uncoated aluminum where indicated and where necessary for strength.

### 3.2 ROOF FLASHING INSTALLATION

- A. General: Install sheet metal flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, set units true to line, and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant. In first paragraph below, SMACNA does not recommend fastener spacing for the continuous cleat. Revise if Project is FMG insured.

### 3.3 CLEANING AND PROTECTION

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean and neutralize flux materials. Clean off excess solder and sealants.
- C. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions.

END OF SECTION 076200

## **SECTION 078413**

### **PENETRATION FIRESTOPPING**

#### **PART 1 - GENERAL**

##### **1.1 SUMMARY**

- A. This Section includes through-penetration firestop systems for penetrations through fire-resistance-rated constructions, including both empty openings and openings containing penetrating items.

##### **1.2 SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For each through-penetration firestop system, submit documentation, including illustrations, from a qualified testing and inspecting agency, showing each type of construction condition penetrated, relationships to adjoining construction, and type of penetrating item.
  - 1. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular through-penetration firestop condition, submit illustration, with modifications marked, approved by through-penetration firestop system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

##### **1.3 PERFORMANCE REQUIREMENTS**

- A. General: For penetrations through fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.
- B. Rated Systems: Provide through-penetration firestop systems with the following ratings determined per ASTM E 814:
  - 1. F-Rated Systems: Provide through-penetration firestop systems with F-ratings indicated, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.
- C. For through-penetration firestop systems exposed to view, traffic, moisture, and physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.
  - 1. For piping penetrations for plumbing and wet-pipe sprinkler systems, provide moisture-resistant through-penetration firestop systems.
  - 2. For floor penetrations with annular spaces exceeding 4 inches in width and exposed to possible loading and traffic, provide firestop systems capable of supporting floor loads involved, either by installing floor plates or by other means.

3. For penetrations involving insulated piping, provide through-penetration firestop systems not requiring removal of insulation.
- D. For through-penetration firestop systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

#### 1.4 QUALITY ASSURANCE

- A. Installation Responsibility: Assign installation of through-penetration firestop systems and fire-resistive joint systems in Project to a single qualified installer.
- B. Fire-Test-Response Characteristics: Provide through-penetration firestop systems that comply with the following requirements and those specified in Part 1 "Performance Requirements" Article:
  1. Through-penetration firestop systems are identical to those tested per testing standard referenced in "Part 1 Performance Requirements" Article. Provide rated systems bearing classification marking of qualified testing and inspecting agency.
- C. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the through-penetration firestop systems indicated for each application that are produced by one of the following manufacturers:
  1. Grace, W. R. & Co. - Conn.
  2. Hilti, Inc.
  3. Nelson Firestop Products.
  4. Tremco; Sealant/Weatherproofing Division.

#### 2.2 FIRESTOPPING

- A. Compatibility: Provide through-penetration firestop systems that are compatible with one another; with the substrates forming openings; and with the items, if any, penetrating through-penetration firestop systems, under conditions of service and application, as demonstrated by through-penetration firestop system manufacturer based on testing and field experience.
- B. Accessories: Provide components for each through-penetration firestop system that are needed to install fill materials and to comply with Part 1 "Performance Requirements" Article. Use only components specified by through-penetration firestop system manufacturer and approved by qualified testing and inspecting agency for firestop systems indicated.

## **PART 3 - EXECUTION**

### **3.1 THROUGH-PENETRATION FIRESTOP SYSTEM INSTALLATION**

- A. General: Install through-penetration firestop systems to comply with Part 1 "Performance Requirements" Article and with firestop system manufacturer's written installation instructions and published drawings for products and applications indicated.
- B. Install forming/damming/backing materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
  - 1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestop systems.
- C. Install fill materials for firestop systems by proven techniques to produce the following results:
  - 1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
  - 2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
  - 3. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.
- D. Identification: Identify through-penetration firestop systems with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of edge of the firestop systems so that labels will be visible to anyone seeking to remove penetrating items or firestop systems. Use mechanical fasteners for metal labels. Include the following information on labels:
  - 1. The words "Warning - Through-Penetration Firestop System - Do Not Disturb. Notify Building Management of Any Damage."
  - 2. Contractor's name, address, and phone number.
  - 3. Through-penetration firestop system designation of applicable testing and inspecting agency.
  - 4. Date of installation.
  - 5. Through-penetration firestop system manufacturer's name.
  - 6. Installer's name.

### **3.2 THROUGH-PENETRATION FIRESTOP SYSTEM SCHEDULE**

- A. Where UL-classified systems are indicated, they refer to alpha-alpha-numeric designations listed in UL's "Fire Resistance Directory" under product Category XHEZ.
- B. Firestop Systems with No Penetrating Items:
  - 1. UL-Classified System: C-AJ-0006.
- C. Firestop Systems for Metallic Pipes, Conduit, or Tubing:
  - 1. UL-Classified System: C-AJ-1022.

- D. Firestop Systems for Nonmetallic Pipe, Conduit, or Tubing:
  - 1. UL-Classified System: C-AJ-2042.
- E. Firestop Systems for Electrical Cables:
  - 1. UL-Classified System: C-AJ-3003.
- F. Firestop Systems for Cable Trays:
  - 1. UL-Classified System: C-AJ-4001.
- G. Firestop Systems for Insulated Pipes:
  - 1. UL-Classified System: C-AJ-5004.
- H. Firestop Systems for Miscellaneous Electrical Penetrants:
  - 1. UL-Classified System: C-AJ-6017.
- I. Firestop Systems for Miscellaneous Mechanical Penetrants:
  - 1. UL-Classified Systems: C-AJ-7005.

END OF SECTION 078413

## **SECTION 079200 JOINT SEALANTS**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. This Section includes joint sealants for the following applications, including those specified by reference to this Section:
  - 1. Exterior joints in vertical surfaces and horizontal nontraffic surfaces.
  - 2. Exterior joints in horizontal traffic surfaces.
  - 3. Interior joints in vertical surfaces and horizontal nontraffic surfaces.
  - 4. Interior joints in horizontal traffic surfaces.
- B. See Division 32 Section "Concrete Paving Joint Sealants" for sealing joints in pavements, walkways, and curbing.
- C. See Division 08 Section "Glazing" for glazing sealants.

#### **1.2 SUBMITTALS**

- A. Product Data: For each joint-sealant product indicated.
- B. Samples: For each type and color of joint sealant required, provide Samples with joint sealants in 1/2-inch wide joints formed between two 6-inch long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- C. Preconstruction field test reports.
- D. Compatibility and adhesion test reports.
- E. Product test reports.

#### **1.3 PERFORMANCE REQUIREMENTS**

- A. Provide elastomeric joint sealants that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.
- B. Provide joint sealants for interior applications that establish and maintain airtight and water-resistant continuous joint seals without staining or deteriorating joint substrates.

#### **1.4 QUALITY ASSURANCE**

- A. Preconstruction Compatibility and Adhesion Testing: Submit samples of materials that will contact or affect joint sealants to joint-sealant manufacturers for testing according to manufacturer's standard test method to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.

- B. Preconstruction Field-Adhesion Testing: Before installing elastomeric sealants, field test their adhesion to Project joint substrates according to the method in ASTM C 1193 and in accordance with manufacturer's field adhesion test procedure (see Section 1.5.B); each that is appropriate for the types of Project joints.
- C. Mockups: Build mockups incorporating sealant joints, as follows, to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution:
  - 1. Joints in mockups of assemblies specified in other Sections that are indicated to receive elastomeric joint sealants, which are specified by reference to this Section.

## 1.5 WARRANTY

- A. Special installer's warranty for sealant installed at exterior side of precast concrete wall panel joints: 5 years period from date of Substantial Completion.
- B. Special manufacturer's warranty for sealant installed exterior side of precast concrete wall panel joints: 20 years from date of Substantial Completion (upon documentation of field adhesion tests as per the manufacturers field adhesion test procedure).
- C. Special Installer's Warranty for other sealants: Installer's standard form in which Installer agrees to repair or replace elastomeric joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
  - 1. Warranty Period: 2 years from date of Substantial Completion.
- D. Special Manufacturer's Warranty: Manufacturer's standard form in which elastomeric sealant manufacturer agrees to furnish elastomeric joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.
  - 1. Warranty Period: 10 years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the products listed in other Part 2 articles.

### 2.2 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer, based on testing and field experience.
- B. VOC Content of Interior Sealants: Provide interior sealants and sealant primers that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Sealants: 250 g/L.
2. Sealant Primers for Nonporous Substrates: 250 g/L.
3. Sealant Primers for Porous Substrates: 775 g/L.

## 2.3 ELASTOMERIC JOINT SEALANTS

- A. Elastomeric Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.
- B. Stain-Test-Response Characteristics: Where elastomeric sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.
- C. Suitability for Contact with Food: Where elastomeric sealants are indicated for joints that will come in repeated contact with food, provide products that comply with 21 CFR 177.2600.
- D. Single-Component Neutral and Basic-Curing Silicone Sealant:
  1. Products:
    - a. Dow Corning Corporation; 790.
    - b. Tremco; Spectrem 1.
    - c. Pecora Corporation; 890.
    - d. GE Silicones; SilPruf NB SCS9000 NB.
  2. Type and Grade: S (single component) and NS (nonsag).
  3. Class: 100/50.
  4. Use Related to Exposure: NT (nontraffic).
  5. Uses Related to Joint Substrates: M, G, A, and, as applicable to joint substrates indicated, O.
  6. Stain-Test-Response Characteristics: Non-staining to porous substrates per ASTM C 1248.
- E. Single-Component Neutral-Curing Silicone Sealant:
  1. Products:
    - a. Dow Corning Corporation; 799.
    - b. GE Silicones; UltraGlaze SSG4000.
    - c. GE Silicones; UltraGlaze SSG4000AC.
    - d. Tremco; Proglaze SG.
    - e. Tremco; Spectrem 2.
  2. Type and Grade: S (single component) and NS (nonsag).
  3. Class: 25.
  4. Use Related to Exposure: NT (nontraffic).
  5. Uses Related to Joint Substrates: G, A, and, as applicable to joint substrates indicated, O.
- F. Single-Component Mildew-Resistant Neutral-Curing Silicone Sealant:
  1. Products:



- a. Pecora Corporation; 898.
    - b. Tremco; Tremsil 600 White.
  2. Type and Grade: S (single component) and NS (nonsag).
  3. Class: 25.
  4. Use Related to Exposure: NT (nontraffic).
  5. Uses Related to Joint Substrates: M, G, A, and, as applicable to joint substrates indicated, O.
- G. Single-Component Nonsag Urethane Sealant:
  1. Products:
    - a. Sika Corporation, Inc.; Sikaflex - 1a.
    - b. Sonneborn, Division of ChemRex Inc.; Ultra.
    - c. Sonneborn, Division of ChemRex Inc.; NP 1.
    - d. Tremco; Vulkem 116.
  2. Type and Grade: S (single component) and NS (nonsag).
  3. Class: 25.
  4. Uses Related to Exposure: T (traffic) and NT (nontraffic).
  5. Uses Related to Joint Substrates: M, [G,] A, and, as applicable to joint substrates indicated, O.
- H. Single-Component Pourable Urethane Sealant:
  1. Products:
    - a. Sika Corporation, Inc.; Sikaflex - 1CSL.
    - b. Sonneborn, Division of ChemRex Inc.; SL 1.
    - c. Tremco; Vulkem Nova 300 SSL.
  2. Type and Grade: S (single component) and P (pourable).
  3. Class: 50.
  4. Uses Related to Exposure: T (traffic) and NT (nontraffic).
  5. Uses Related to Joint Substrates: M, [G,] A, and, as applicable to joint substrates indicated, O.
- I. Single-Component Pourable Urethane Sealant:
  1. Products:
    - a. Bostik Findley; Chem-Calk 950.
    - b. Pecora Corporation; Urexpan NR-201.
    - c. Polymeric Systems Inc.; Flexiprene 952.
    - d. Schnee-Morehead, Inc.; Permathane SM7101.
    - e. Tremco; Tremflex S/L.
    - f. Tremco; Vulkem 45.
  2. Type and Grade: S (single component) and P (pourable).
  3. Class: 25.
  4. Use Related to Exposure: T (traffic).
  5. Uses Related to Joint Substrates: M, [G,] A, and, as applicable to joint substrates indicated, O.

## 2.4 LATEX JOINT SEALANTS

- A. Latex Sealant: Comply with ASTM C 834, Type O P, Grade NF.
- B. Products:
  - 1. Pecora Corporation; AC-20+.
  - 2. Schnee-Morehead, Inc.; SM 8200.
  - 3. Sonneborn, Division of ChemRex Inc.; Sonolac.
  - 4. Tremco; Tremflex 834.

## 2.5 ACOUSTICAL JOINT SEALANTS

- A. Acoustical Sealant for Exposed and Concealed Joints: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834 that effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
  - 1. Products:
    - a. Pecora Corporation; AC-20 FTR Acoustical and Insulation Sealant.
    - b. United States Gypsum Co.; SHEETROCK Acoustical Sealant.
    - c. Tremco; Tremco Acoustical Sealant
- B. Acoustical Sealant for Concealed Joints: Manufacturer's standard, nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic-rubber sealant recommended for sealing interior concealed joints to reduce airborne sound transmission.
  - 1. Available Products:
    - a. Pecora Corporation; BA-98.
    - b. Tremco; Tremco Acoustical Sealant.

## 2.6 PREFORMED JOINT SEALANTS

- A. Preformed Silicone-Sealant System: Manufacturer's standard system consisting of precured low-modulus silicone extrusion, in sizes to fit joint widths indicated, combined with a neutral-curing silicone sealant for bonding extrusions to substrates.
  - 1. Products:
    - a. Dow Corning Corporation; 123 Silicone Seal.
    - b. GE Silicones; UltraSpan US1100.
    - c. Pecora Corporation; Sil-Span.
    - d. Tremco; Spectrem Ez Seal.
- B. Pre-Compressed Foam Sealants: Manufacturer's standard mildew-resistant, non-migratory, preformed, pre-compressed, open-cell foam sealant that is manufactured from high-density urethane foam impregnated with a nondrying, water-repellent agent. Custom size ¾" x 2" for precast concrete wall panel joints.
  - 1. Provide following product or equal product that meets specified performance criteria in this section:

a. EMSEAL Joint Systems, Ltd.; Backerseal

2. Pre-compressed sealant shall be pre-formed, pre-compressed, self-expanding, sealant system. Expanding foam to be cellular foam impregnated with a water-based, non-drying, polymer-modified 100% acrylic dispersion.
3. Material shall be capable of movements of +25%, -25% (50% total) of nominal material size.
4. At precast concrete joints, pre-compressed sealant to be installed in two layers as shown on drawings at depth sufficient to allow installation of properly sized backer rod and liquid sealant in front of material.
5. Pre-Compressed foam sealant must be supplied pre-compressed to less than the joint size, packaged in reels or shrink-wrapped lengths (sticks) with a mounting adhesive on one face, for ease of installation.

2.7 JOINT-SEALANT BACKING

- A. General: Provide sealant backings of material and type that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Cylindrical Sealant Backings: ASTM C 1330, Type C closed-cell material with a surface skin and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance:
- C. Elastomeric Tubing Sealant Backings: Neoprene, butyl, EPDM, or silicone tubing complying with ASTM D 1056, nonabsorbent to water and gas, and capable of remaining resilient at temperatures down to minus 26°F. Provide products with low compression set and of size and shape to provide a secondary seal, to control sealant depth, and to otherwise contribute to optimum sealant performance.
- D. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

2.8 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants.
  - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant.
    - a. Clean porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air.
  - 2. Remove laitance and form-release agents from concrete.
    - a. Clean nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.
- B. Joint Priming: Prime joint substrates based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

### 3.2 INSTALLATION

- A. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- B. Acoustical Sealant Application Standard: Comply with recommendations in ASTM C 919 for use of joint sealants in acoustical applications as applicable to materials, applications, and conditions indicated.
- C. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
  - 1. Do not leave gaps between ends of sealant backings.
  - 2. Do not stretch, twist, puncture, or tear sealant backings.
  - 3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
- D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

- E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
  - 1. Place sealants so they directly contact and fully wet joint substrates.
  - 2. Completely fill recesses in each joint configuration.
  - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
  - 1. Remove excess sealant from surfaces adjacent to joints.
  - 2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
  - 3. Provide concave joint configuration per Figure 5A in ASTM C 1193, unless otherwise indicated.
- G. Installation of Preformed Silicone-Sealant System: Comply with manufacturer's written instructions.
- H. Installation of Pre-Compressed Foam Sealants: Install each length of sealant immediately after removing protective wrapping, taking care not to pull or stretch material, producing seal continuity at ends, turns, and intersections of joints. Install in complete accordance with sealant manufacturer's written instructions. No drilling, or screwing, or fasteners of any type are permitted to anchor the system into the substrate.
- I. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

### 3.3 JOINT-SEALANT SCHEDULE

- A. Joint-Sealant Application: Exterior vertical and horizontal non-traffic construction joints in cast-in-place concrete.
  - 1. Joint Sealant: Single-component neutral- and basic-curing silicone sealant.
  - 2. Joint-Sealant Color: Custom color as selected by Architect.
- B. Joint-Sealant Application: Exterior vertical control and expansion joints in unit masonry.
  - 1. Joint Sealant: Single-component neutral- and basic-curing silicone sealant.
  - 2. Joint-Sealant Color: Custom color as selected by Architect.
- C. Joint-Sealant Application: Exterior vertical joints between different materials listed above.
  - 1. Joint Sealant: Single-component neutral-curing silicone sealant] [Single-component neutral-curing silicone sealant.
  - 2. Joint-Sealant Color: Custom color as selected by Architect.
- D. Joint-Sealant Application: Exterior perimeter joints at frames of doors, windows and louvers.
  - 1. Joint Sealant: Single-component neutral-curing silicone sealant.

2. Joint-Sealant Color: Custom color as selected by Architect.
- E. Joint-Sealant Application: Vertical control and expansion joints on exposed interior surfaces of exterior walls.
  1. Joint Sealant: Single-component non-sag urethane sealant
  2. Joint-Sealant Color: From manufacturer's standard color chart.
- F. Joint-Sealant Application: Interior perimeter joints of exterior openings.
  1. Joint Sealant: Single-component non-sag urethane sealant.
  2. Joint-Sealant Color: From manufacturer's standard color chart.
- G. Joint-Sealant Application: Interior ceramic tile expansion, control, contraction, and isolation joints in horizontal traffic surfaces.
  1. Joint Sealant: Multicomponent non-sag urethane sealant, Multicomponent pourable urethane sealant or Single-component pourable urethane sealant.
  2. Joint-Sealant Color: From manufacturer's standard color chart.
- H. Joint-Sealant Application: Interior joints between plumbing fixtures and adjoining walls, floors, and counters.
  1. Joint Sealant: Single-component mildew-resistant neutral-curing silicone sealant.
  2. Joint-Sealant Color: From manufacturer's standard color chart.
- I. Joint-Sealant Application: Vertical joints on exposed surfaces of interior walls and partitions.
  1. Joint Sealant: Multicomponent non-sag urethane sealant, Single-component non-sag urethane sealant or Latex sealant.
  2. Joint-Sealant Color: From manufacturer's standard color chart.
- J. Joint-Sealant Application: Perimeter joints between interior wall surfaces and frames of interior doors and windows.
  1. Joint Sealant: Latex sealant.
  2. Joint-Sealant Color: From manufacturer's standard color chart.
- K. Joint-Sealant Application: Interior control, expansion, and isolation joints in horizontal traffic surfaces.
  1. Joint Sealant: Multicomponent non-sag urethane sealant, Multicomponent pourable urethane sealant or Single-component pourable urethane sealant.
  2. Joint-Sealant Color: From manufacturer's standard color chart.

END OF SECTION 079200

## SECTION 081113 HOLLOW METAL DOORS AND FRAMES

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Standard hollow metal doors and frames.
  - 2. ICC 500-2014 Storm Shelter Rated Doors and Frames

#### 1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Include elevations, door edge details, frame profiles, metal thicknesses, preparations for hardware, and other details.
- C. Samples for Initial Selection: For units with factory-applied color finishes.
- D. Samples for Verification: For each type of exposed finish required.
- E. Schedule: Prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings.

#### 1.3 QUALITY ASSURANCE

- A. Smoke-Control Door Assemblies: Comply with NFPA 105 or UL 1784.
- B. ICC 500 Storm Shelter Openings: Provide complete door systems for tornado storm shelters, and other areas of refuge, complying and tested according to FEMA 361, Third Edition (2015), Design and Construction Guidance for Community Safe Rooms; and ICC 500 (2014), ICC/NSSA Standard for the Design and Construction of Storm Shelters.
  - 1. Each unit to bear third party permanent label indicating compliance with the referenced testing standards.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Benchmark; a division of Therma-Tru Corporation.
  - 2. Ceco Door Products; an Assa Abloy Group company.
  - 3. Deansteel Manufacturing Company, Inc.

4. Steelcraft; an Allegion company.
5. Windsor Republic Doors.
6. Mesker Doors
7. Curries Manufacturing

## 2.2 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, CS, Type B; suitable for exposed applications.
- B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, CS, Type B.
- C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum [A40] [G60 or A60] metallic coating.
- D. Frame Anchors: ASTM A 591/A 591M, Commercial Steel (CS), 40Z coating designation; mill phosphatized.
  1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.
- E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.
- F. Grout: ASTM C 476, except with a maximum slump of 4 inches, as measured according to ASTM C 143/C 143M.
- G. Mineral-Fiber Insulation: ASTM C 665, Type I.
- H. Glazing: Division 08 Section "Glazing."
- I. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat.

## 2.3 STANDARD HOLLOW METAL DOORS

- A. General: Comply with ANSI/SDI A250.8.
  1. Design: Flush panel.
  2. Core Construction: Manufacturer's standard kraft-paper honeycomb, polystyrene, polyurethane, polyisocyanurate, mineral-board, or vertical steel-stiffener core.
    - a. Thermal-Rated (Insulated) Doors: R-value of not less than 12.3 deg F x h x sq. ft./Btu when tested according to ASTM C 1363.
  3. Vertical Edges for Single-Acting Doors: Square edge.
  4. Top and Bottom Edges: Closed with flush or inverted 0.042-inch- thick, end closures or channels of same material as face sheets.
  5. Tolerances: SDI 117, "Manufacturing Tolerances for Standard Steel Doors and Frames."
- B. Exterior Doors: Face sheets fabricated from metallic-coated steel sheet. Comply with ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:



1. Level 3 and Physical Performance Level A (Extra Heavy Duty), Model 1 (Full Flush).

- a. Width: 1-3/4 inches.

- C. Interior Doors: Face sheets fabricated from cold-rolled steel sheet. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:

1. Level 2 and Physical Performance Level B (Heavy Duty), Model 1 (Full Flush).

- a. Width: 1-3/4 inches.

- b. Undercut: 3/4" undercut on all standard interior doors unless otherwise noted.

- D. Hardware Reinforcement: ANSI/SDI A250.6.

## 2.4 HOLLOW METAL DOORS FOR ICC 500 STORM SHELTER RATED OPENINGS

- A. General: Provide complete tornado resistant door and frame shelter assemblies constructed to resist the design wind pressures for components and cladding and missile impact loads as described in ICC 500 – 2014, ICC/NSSA Stand for the Design and Construction of Storm Shelters. Only single opening and paired opening doors and their frames constructed to resist calculated design wind pressures and laboratory tested missile impacts are acceptable.

1. Door systems, both single door and paired openings, tested and complying with ICC 500 (2014) and FEMA 361 (2015), Design and Construction Guidance for Community Safe Room and supported by third party test results.
  2. Sheets fabricated on exterior opening storm commercial quality hot dipped zinc coated steel complying with ASTM A924 A60. Gages to bin in accordance with manufacturers tested assemblies.
  3. Vertical Edges: Vertical edges to have the face sheets jointed by a continuous weld extending the full height of the door. Welds are to be ground, filled and dressed smooth. Beveled lock edge, 1/8" in 2".
  4. Top Edge: Reinforce top of doors with a continuous steel channel extending the full width of the door and welded to the face sheet. Doors with an inverted top channel to include a steel closure channel, screw attached and welded in place with the web of the channel flush with the face sheet of the door. Plastic or composite channel fillers are not acceptable.
  5. Hinge reinforcement: Minimum 7 gage plate 1-1/4"x9".
  6. Factory glazed narrow lite view window for exterior doors (4" x 25" or 5" x 20")

- B. Manufacturers:

1. Deansteel Manufacturing Company, Inc. – FEMA 361 Series
  2. Steelcraft; an Allegion company – Paladin Series.

## 2.5 STANDARD HOLLOW METAL FRAMES

- A. General: Comply with ANSI/SDI A250.8.

- B. Exterior Frames: Fabricated from metallic-coated steel sheet.

1. Fabricate frames with mitered or coped corners.

2. Fabricate frames as face welded unless otherwise indicated.
3. Frames for Level 3 Steel Doors: 0.053-inch thick steel sheet.

C. Interior Frames: Fabricated from cold-rolled steel sheet.

1. Fabricate frames with mitered or coped corners.
2. Fabricate frames as face welded unless otherwise indicated.
3. Fabricate knocked-down, drywall slip-on frames for in-place gypsum board partitions.
4. Frames for Level 2 Steel Doors: 0.053-inch thick steel sheet.
5. Frames for Borrowed Lights: Same as adjacent door frame.

D. Hardware Reinforcement: ANSI/SDI A250.6.

## 2.6 FRAMES FOR ICC 500 STORM SHELTER RATED OPENINGS

A. General: Subject to the same compliance standards and requirements as standard hollow metal frames, provide complete tornado resistant door and frame assemblies, for both single doors and paired openings, tested and labeled as complying with ICC 500 and FEMA 361 and supported by third party test results.

1. Fabricate exterior and interior frames from 14 gage hot dipped zinc coated steel complying with ASTM designations A924 A60.
2. Manufacturers: Same as Door Manufacturer.

## 2.7 FRAME ANCHORS

A. Jamb Anchors:

1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.042 inch thick, with corrugated or perforated straps not less than 2 inches wide by 10 inches long; or wire anchors not less than 0.177 inch thick.
2. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.042 inch thick.
3. Compression Type for Drywall Slip-on Frames: Adjustable compression anchors.
4. Postinstalled Expansion Type for In-Place Concrete or Masonry: Minimum 3/8-inch- diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.
5. FEMA 361 Tornado Safe Room Anchors: Existing Opening type anchors.

B. Floor Anchors: Formed from same material as frames, not less than 0.042 inch thick, and as follows:

1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.

## 2.8 HOLLOW METAL PANELS

A. Provide hollow metal panels of same materials, construction, and finish as specified for adjoining hollow metal work.

## 2.9 STOPS AND MOLDINGS

- A. Moldings for Glazed Lites in Doors: Minimum 0.032 inch thick, same material as door face sheet.
- B. Fixed Frame Moldings: Formed integral with hollow metal frames, a minimum of 5/8 inch high unless otherwise indicated.
- C. Loose Stops for Glazed Lites in Frames: Minimum 0.032 inch thick, same material as frames.
- D. Terminated Stops: Where indicated, terminate stops 6 inches above finish floor with a [45] [90]-degree angle cut, and close open end of stop with steel sheet closure. Cover opening in extension of frame with welded-steel filler plate, with welds ground smooth and flush with frame.

## 2.10 ACCESSORIES

- A. Mullions and Transom Bars: Join to adjacent members by welding or rigid mechanical anchors.
- B. Ceiling Struts: Minimum 1/4-inch-thick by 1-inch- wide steel.
- C. Grout Guards: Formed from same material as frames, not less than 0.016 inch thick.

## 2.11 FABRICATION

- A. Tolerances: Fabricate hollow metal work to tolerances indicated in SDI 117.
- B. Hollow Metal Doors:
  - 1. Exterior Doors: Provide weep-hole openings in bottom of exterior doors. Seal joints in top edges of doors against water penetration.
  - 2. Glazed Lites: Factory cut openings in doors.
  - 3. Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated.
- C. Hollow Metal Frames: Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
  - 1. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.
  - 2. Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by butt welding.
  - 3. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
  - 4. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
  - 5. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
  - 6. Jamb Anchors: Provide number and spacing of anchors as follows:
    - a. Masonry Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:

- 1) Two anchors per jamb up to 60 inches high.
    - 2) Three anchors per jamb from 60 to 90 inches high.
    - 3) Four anchors per jamb from 90 to 120 inches high.
    - 4) Four anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 120 inches high.
  - b. Stud-Wall Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:
    - 1) Three anchors per jamb up to 60 inches high.
    - 2) Four anchors per jamb from 60 to 90 inches high.
    - 3) Five anchors per jamb from 90 to 96 inches high.
    - 4) Five anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 96 inches high.
    - 5) Two anchors per head for frames more than 42 inches wide and mounted in metal-stud partitions.
  - c. Compression Type: Not less than two anchors in each jamb.
  - d. Postinstalled Expansion Type: Locate anchors not more than 6 inches from top and bottom of frame. Space anchors not more than 26 inches o.c.
7. Door Silencers: Except on weather-stripped doors, drill stops to receive door silencers.
  - a. Single-Door Frames: Three door silencers.
  - b. Double-Door Frames: Two door silencers.
- D. Hardware Preparation: Factory prepare hollow metal work to receive templated mortised hardware according to the Door Hardware Schedule and templates furnished as specified in Division 08 Section "Door Hardware."
  1. Locate hardware as indicated, or if not indicated, according to ANSI/SDI A250.8.
  2. Reinforce doors and frames to receive nontemplated, mortised and surface-mounted door hardware.
  3. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.
  4. Coordinate locations of conduit and wiring boxes for electrical connections with Division 26 electrical Sections.
- E. Stops and Moldings: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints.
  1. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of hollow metal work.
  2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
  3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.
  4. Provide loose stops and moldings on inside of hollow metal work.
  5. Coordinate rabbet width between fixed and removable stops with type of glazing and type of installation indicated.

## 2.12 STEEL FINISHES

- A. Prime Finish: Apply manufacturer's standard primer immediately after cleaning and pretreating.

1. Shop Primer: ANSI/SDI A250.10.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

##### **A. Hollow Metal Frames: Comply with ANSI/SDI A250.11.**

1. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
  - a. At fire-protection-rated openings, install frames according to NFPA 80.
  - b. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
  - c. Install frames with removable glazing stops located on secure side of opening.
  - d. Install door silencers in frames before grouting.
  - e. Remove temporary braces necessary for installation only after frames have been properly set and secured.
  - f. Check plumbness, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
  - g. Field apply bituminous coating to backs of frames that are filled with grout containing antifreezing agents.
2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors.
  - a. Floor anchors may be set with powder-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.
3. Metal-Stud Partitions: Solidly pack mineral-fiber insulation behind frames.
4. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.
5. Concrete Walls: Solidly fill space between frames and concrete with grout. Take precautions, including bracing frames, to ensure that frames are not deformed or damaged by grout forces.
6. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
7. In-Place Gypsum Board Partitions: Secure frames in place with postinstalled expansion anchors through floor anchors at each jamb. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
8. Ceiling Struts: Extend struts vertically from top of frame at each jamb to overhead structural supports or substrates above frame unless frame is anchored to masonry or to other structural support at each jamb. Bend top of struts to provide flush contact for securing to supporting construction. Provide adjustable wedged or bolted anchorage to frame jamb members.
9. Installation Tolerances: Adjust hollow metal door frames for squareness, alignment, twist, and plumb to the following tolerances:

- a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
    - b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
    - c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
    - d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.
  - B. Hollow Metal Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.
    - 1. Non-Fire-Rated Standard Steel Doors:
      - a. Jambs and Head: 1/8 inch plus or minus 1/16 inch.
      - b. Between Edges of Pairs of Doors: 1/8 inch plus or minus 1/16 inch.
      - c. Between Bottom of Door and Top of Threshold: Maximum 3/8 inch.
      - d. Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4 inch.
    - 2. Smoke-Control Doors: Install doors according to NFPA 105.
  - C. Glazing: Comply with installation requirements in Division 08 Section "Glazing" and with hollow metal manufacturer's written instructions.
    - 1. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.
- 3.2 ADJUSTING AND CLEANING
- A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow metal work that is warped, bowed, or otherwise unacceptable.
  - B. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.
  - C. Metallic-Coated Surfaces: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

END OF SECTION 081113

**SECTION 085653**  
**WIND & IMPACT SECURITY WINDOWS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
  - 1. Wind and Impact Aluminum Security Windows.
- B. Related Sections:
  - 1. Section 07 62 00 - Sheet Metal Flashing and Trim
  - 2. Section 07 92 00 - Joint Sealants

**1.2 ACTION SUBMITTALS**

- A. Refer to Section 01 33 00 Submittal Procedures.
- B. Product Data: For each type of framing and glazing including manufacturer recommended installation instructions.
- C. Product Data: For each type of framing and glazing including manufacturer recommended installation instructions.
- D. Shop Drawings: Include plans, elevations, sections, details, attachment to other work.
- E. Samples: For each exposed finish.

**1.3 INFORMATIONAL SUBMITTALS**

- A. Product Certificates: Indicating compliance with ICC 500 – 2014 and FEMA P-361 2015 requirements
- B. Qualification Data: For Installer and Testing Agency.
- C. Warranty: Sample of finish warranty

**1.4 CLOSEOUT SUBMITTALS**

- A. Maintenance data.

**1.5 DELIVERY, STORAGE AND HANDLING**

- A. Refer to Section 01 60 00 Product Requirements.

## 1.6 WARRANTY

- A. Finish Warranty: Manufacturer's warranty against deterioration of factory finishes for the period of 5 years from the date of Substantial Completion.
- B. Glass Warranty: Manufacturer's warranty against defects in material and workmanship resulting in edge separation or delamination for a period of 5 years from the date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 FRAMING

- A. Basis of Design: Insulgard TOR-GARD TTH600 Tornado and Hurricane Store Shelter Window System by Insulgard Security Products; Phone 800.624.6315; website [www.insulgard.com](http://www.insulgard.com)
- B. Description
  - 1. Factory fabricated framing constructed from either 6005-T5 or 6105-T5 extruded aluminum with integral weep design to allow water to vent to the exterior along horizontal members. Thermal separation of frame using polyamide strip.
  - 2. Dimensions:
    - a. Head, Jamb, and Sill Members: 2-1/2 inches by 6 inches.
    - b. Mullion and Intermediate Horizontal Members: 3-1/4 inch face
  - 3. Unit to be permanently marked with certification label of the certified testing agency acceptable to the authorities having jurisdiction. Label to include:
    - a. Design Pressure
    - b. Tested Pressure
    - c. Missile Criteria
    - d. ICC-500 (2014) Certification Listing

### 2.2 GLAZING

- A. Glazing Material: Insulating Glass Clad Polycarbonate
  - 1. Wind, Impact and Level 3 Ballistic Resistant: TOR-GARD 30 IG

### 2.3 PERFORMANCE CRITERIA

- A. Indicated areas of this project have been designed for occupancy as a storm shelter. The Work identified in this Section is a component of that security occupancy as follows:
  - 1. Type of Shelter: Tornado
- B. Shelter Design Wind Speeds:
  - 1. Tornado 250 MPH



C. Debris Hazard

1. FEMA P-361-15 Compliant: Pass missile-impact tests according to FEMA P 361-15 / ICC 500-2014 in accordance with:
  - a. ASTM E1886 - Standard Test Method For Performance Of Exterior Windows, Curtain Walls, Doors And Impact Protective Systems Impacted By Missiles and Exposed To Cyclic Pressure Differentials
  - b. ASTM E1996 - Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors and Impact Protective Systems Impacted by Windborne Debris in Hurricanes.
2. Tornado: Resists impact of a 15 pound 2 by 4 at 100 MPH for vertical surfaces.

D. Pressure Testing

1. FEMA P-361 Compliant: Pass static pressure tests and cyclic tests according to FEMA P 361-2015/ICC 500-2014 in accordance with:
  - a. ASTM E330 - Standard Test Method For Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference

E. Ballistic Resistant: Level 3 in accordance with UL 752 – Standard for Bullet-Resisting Equipment.

F. Energy Performance: Certify and label energy performance according to NFRC as follows:

1. NFRC Model Size: 47-1/4 by 59 inches
2. Thermal Transmittance (U-factor): Fixed glazing and framing areas shall have U-factor of not more than 0.37 as determined according to NFRC 100.
3. Solar Heat Gain Coefficient: Fixed glazing and framing areas shall have a solar heat gain coefficient of no greater than 0.45 as determined according to NFRC 200.
4. Condensation Resistance: Fixed glazing and framing areas shall have an NFRC-certified condensation resistance rating of no less than 60 as determined according to NFRC 500.

## 2.4 FABRICATION

- A. Tolerances: All joints and connections shall be tight, providing hairline joints and true alignment of adjacent members

## 2.5 FRAMING FINISH

A. Factory-applied finish:

1. [Color Anodic Finish]: Architectural Class I, color coating AA-M10C22A42/A44 Mechanical Finish Chemical Finish: etched, medium matte; 0.70 mils minimum complying with AAMA 611 "Voluntary Specification for Anodized Architectural Aluminum".
  - a. Color: Dark Bronze.

## 2.6 ACCESSORIES

- A. Anchors: Fully concealed in accordance with performance requirements
- B. Glazing Gaskets: Manufacturer supplied EPDM gasket utilized as component of the tested assembly.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Verify field dimensions of opening prior to fabrication of windows.
- B. Coordinate structural requirements to ensure proper attachment and support.

### 3.2 INSTALLATION

- A. Install windows in accordance with manufacturer's recommendations and approved shop drawings.
- B. Provide required support and securely fasten and set windows plumb, square, and level without twist or bow.
- C. Apply sealant in accordance with window and sealant manufacturer's recommendations as indicated in installation instructions. Wipe off excess, and leave exposed sealant surfaces clean and smooth

### 3.3 PROTECTION

- A. Clean in strict accordance with manufacturer's recommended cleaning procedures
- B. Clean and protect windows from damage during construction operations, using glazing manufacturer recommended cleaning agents. If damage occurs, remove and replace as required to provide windows in their original, undamaged condition.
  - 1. In addition to breakage, damage includes but is not limited to crazing, cracking, fissures and delamination.

END OF SECTION 085653

## SECTION 088000 GLAZING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:

- 1. Doors.

#### 1.2 SUBMITTALS

- A. Product Data: For each glass product and glazing material indicated.
- B. Samples: 12-inch- square, for opaque glass.
- C. Preconstruction Adhesion and Compatibility Test Report: From glazing sealant manufacturer.

#### 1.3 DEFINITIONS

- A. Interspace: Space between lites of an insulating-glass unit that contains dehydrated air or a specified gas.
- B. Deterioration of Coated Glass: Defects developed from normal use that are attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in metallic coating.
- C. Deterioration of Insulating Glass: Failure of hermetic seal under normal use that is attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.
- D. Deterioration of Laminated Glass: Defects developed from normal use that are attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.

#### 1.4 PERFORMANCE REQUIREMENTS

- A. General: Provide glazing systems capable of withstanding normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, and installation; failure of sealants or

gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

- B. Glass Design: Glass thickness designations indicated are minimums and are for detailing only. Confirm glass thicknesses by analyzing Project loads and in-service conditions. Provide glass lites in the thickness designations indicated for various size openings, but not less than thicknesses and in strengths (annealed or heat treated) required to meet or exceed the following criteria:
1. Glass Thicknesses: Select minimum glass thicknesses to comply with ASTM E 1300, according to the following requirements:
    - a. Specified Design Wind Loads: As indicated.
      - 1) Basic Wind Speed: 90mph
      - 2) Importance Factor: III.
      - 3) Exposure Category: C.
    - b. Specified Design Snow Loads: As indicated, but not less than snow loads applicable to Project as required by ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 7.0, "Snow Loads."
    - c. Probability of Breakage for Vertical Glazing: 8 lites per 1000 for lites set vertically or not more than 15 degrees off vertical and under wind action.
      - 1) Load Duration: 3 seconds.
    - d. Minimum Glass Thickness for Exterior Lites: Not less than 6.0 mm.
    - e. Thickness of Tinted and Heat-Absorbing Glass: Provide the same thickness for each tint color indicated throughout Project.
  - C. Thermal Movements: Provide glazing that allows for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures acting on glass framing members and glazing components. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
    1. Temperature Change (Range): 120°F, ambient; 180°F, material surfaces.
  - D. Thermal and Optical Performance Properties: Provide glass with performance properties specified based on manufacturer's published test data, as determined according to procedures indicated below:
    1. For monolithic-glass lites, properties are based on units with lites 6.0 mm thick.
    2. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite 6.0 mm thick and a nominal 1/2-inch- wide interspace.
    3. Center-of-Glass Values: Based on using LBL-44789 WINDOW 5.0 computer program for the following methodologies:
      - a. U-Factors: NFRC 100 expressed as Btu/ sq. ft. x h x deg F.
      - b. Solar Heat Gain Coefficient: NFRC 200.
      - c. Solar Optical Properties: NFRC 300.

## 1.5 QUALITY ASSURANCE

- A. Glazing for Fire-Rated Door Assemblies: Glazing for assemblies that comply with NFPA 80 and that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 257.
- B. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.
  - 1. GANA Publications: GANA Laminated Division's "Laminated Glass Design Guide" and GANA's "Glazing Manual."
  - 2. AAMA Publications: AAMA GDSG-1, "Glass Design for Sloped Glazing," and AAMA TIR-A7, "Sloped Glazing Guidelines."
  - 3. IGMA Publication for Sloped Glazing: IGMA TB-3001, "Sloped Glazing Guidelines."
  - 4. IGMA Publication for Insulating Glass: SIGMA TM-3000, "Glazing Guidelines for Sealed Insulating Glass Units."
- C. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of the **Insulating Glass Certification Council**.

## 1.6 WARRANTY

- A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer's standard form, made out to Owner and signed by coated-glass manufacturer agreeing to replace coated-glass units that deteriorate as defined in "Definitions" Article, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
  - 1. Warranty Period: **10** years from date of Substantial Completion.
- B. Manufacturer's Special Warranty on Insulating Glass: Manufacturer's standard form, made out to Owner and signed by insulating-glass manufacturer agreeing to replace insulating-glass units that deteriorate as defined in "Definitions" Article, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
  - 1. Warranty Period: **10** years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 GLASS PRODUCTS

- A. Annealed Float Glass: ASTM C 1036, Type I (transparent flat glass), Quality-Q3; of class indicated.
  - 1. Ultra-Clear (Low-Iron) Float Glass: Class I (clear); with a minimum 91 percent visible light transmission and a minimum solar heat gain coefficient of 0.87.
- B. Ceramic-Coated Vision Glass: Float glass with ceramic enamel applied by silk-screened process and complying with ASTM C 1048, Condition C (other coated glass), Type I (transparent flat glass), Quality-Q3, Specification No. 95-1-31 in GANA Tempering Division's "Engineering Standards Manual," and other requirements specified.

- C. Insulating-Glass Units, General: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, and complying with ASTM E 774 for Class CBA units and with requirements specified in this Article and in Part 2 "Insulating-Glass Units" Article.
1. Provide Kind HS (heat-strengthened) float glass in place of annealed glass where needed to resist thermal stresses induced by differential shading of individual glass lites and to comply with glass design requirements specified in Part 1 "Performance Requirements" Article.
  2. Overall Unit Thickness and Thickness of Each Lite: Dimensions indicated for insulating-glass units are nominal and the overall thicknesses of units are measured perpendicularly from outer surfaces of glass lites at unit's edge.
  3. Sealing System: Dual seal.
  4. Spacer Specifications: Manufacturer's standard spacer material and construction.
  5. Spacer Specifications: Manufacturer's standard spacer material and construction complying with the following requirements:
    - a. Spacer Material: Aluminum with mill or clear anodic finish.
    - b. Corner Construction: Manufacturer's standard corner construction.

## 2.2 FIRE-RATED GLAZING PRODUCTS

- A. Fire-Protection Rating: As indicated for the assembly in which glazing material is installed, and permanently labeled by a testing and inspecting agency acceptable to authorities having jurisdiction.
- B. Film-Faced Ceramic Glazing Material: Proprietary Category II safety glazing product in the form of a 3/16-inch- thick, ceramic glazing material polished on both surfaces, faced on one surface with a clear glazing film, and as follows:
1. Product: "FireLite NT" by Nippon Electric Glass Co., Ltd., and distributed by Technical Glass Products.

## 2.3 GLAZING GASKETS

- A. Dense Compression Gaskets: Molded or extruded gaskets of material indicated below, complying with standards referenced with name of elastomer indicated below, and of profile and hardness required to maintain watertight seal:
1. Neoprene, ASTM C 864.
  2. EPDM, ASTM C 864.
  3. Silicone, ASTM C 1115.
  4. Thermoplastic polyolefin rubber, ASTM C 1115.
  5. Any material indicated above.
- B. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned gaskets of material indicated below; complying with ASTM C 509, Type II, black; and of profile and hardness required to maintain watertight seal:
1. Neoprene.
  2. EPDM.
  3. Silicone.
  4. Thermoplastic polyolefin rubber.
  5. Any material indicated above.

## 2.4 GLAZING SEALANTS

- A. General: Provide products of type indicated, complying with the following requirements:
1. Compatibility: Select glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
  2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
- B. Glazing Sealants for Fire-Resistive Glazing Products: Identical to products used in test assemblies to obtain fire-protection rating.

## 2.5 GLAZING TAPES

- A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based elastomeric tape with a solids content of 100 percent; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; packaged on rolls with a release paper backing; and complying with ASTM C 1281 and AAMA 800 for products indicated below:
1. AAMA 804.3 tape, where indicated.
  2. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
  3. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.
- B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; packaged on rolls with release liner protecting adhesive; and complying with AAMA 800 for the following types:
1. Type 1, for glazing applications in which tape acts as the primary sealant.
  2. Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

## 2.6 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
- B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
- C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
- D. Spacers: Elastomeric blocks or continuous extrusions with a Shore, Type A durometer hardness required by glass manufacturer to maintain glass lites in place for installation indicated.

- E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).
- F. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.
- G. Perimeter Insulation for Fire-Resistive Glazing: Identical to product used in test assembly to obtain fire-resistance rating.

## 2.7 FABRICATION OF GLAZING UNITS

- A. Fabricate glazing units in sizes required to glaze openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.

## 2.8 MONOLITHIC FLOAT-GLASS UNITS

- A. Uncoated Clear Float-Glass Units: Class 1 (clear) float glass.
  - 1. Thickness: 6.0 mm.

## 2.9 MONOLITHIC CERAMIC-COATED VISION-GLASS UNITS

- A. Ceramic-Coated Vision-Glass Units: Class 1 (clear) float glass.
  - 1. Thickness: 6.0 mm.
  - 2. Ceramic Coating Color and Pattern: Match.
    - a. Coating Location: Second surface.

## 2.10 INSULATING-GLASS UNITS

- A. Passive Solar Low-E Insulating-Glass Units:
  - 1. Overall Unit Thickness and Thickness of Each Lite: 25 and 6.0 mm.
  - 2. Interspace Content: Argon.
  - 3. Outdoor Lite: Class 1 (clear) float glass.
    - a. Annealed above 7'-0"
    - b. Kind FT (fully tempered) below 7'-0".
  - 4. Indoor Lite: Class 1 (clear) float glass.
    - a. Annealed above 7'-0"
    - b. Kind FT (fully tempered) below 7'-0".
  - 5. Low-E Coating: Pyrolytic or sputtered on second or third surface.
  - 6. Winter Nighttime U-Factor: 0.35 maximum.



7. Summer Daytime U-Factor: 0.38 maximum.
8. Solar Heat Gain Coefficient: 0.61 maximum.

### **PART 3 - EXECUTION**

#### **3.1 GLAZING**

- A. General: Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
1. Glazing channel dimensions, as indicated on Drawings, provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances. Adjust as required by Project conditions during installation.
  2. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.
  3. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction sealant-substrate testing.
  4. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
  5. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
  6. Provide spacers for glass lites where length plus width is larger than 50 inches.
  7. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.
- B. Tape Glazing: Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.
1. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.
  2. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.
  3. Apply heel bead of elastomeric sealant.
  4. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.
  5. Apply cap bead of elastomeric sealant over exposed edge of tape.
- C. Gasket Glazing (Dry): Fabricate compression gaskets in lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
1. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.
  2. Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without

developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

3. Install gaskets so they protrude past face of glazing stops.

- D. Sealant Glazing (Wet): Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

1. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.
2. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

### 3.2 CLEANING AND PROTECTION

- A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels, and clean surfaces. Protect glass from contact with contaminating substances resulting from construction operations, including weld splatter. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended by glass manufacturer.
- B. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.

END OF SECTION 088000

## **SECTION 092216**

### **NON-STRUCTURAL METAL FRAMING**

#### **PART 1 - GENERAL**

##### **1.1 SUMMARY**

- A. This Section includes non-load-bearing steel framing members for the following applications:
  - 1. Interior framing systems (e.g., supports for partition walls, framed soffits, furring, etc.).

##### **1.2 SUBMITTALS**

- A. Product Data: For each type of product indicated.

##### **1.3 QUALITY ASSURANCE**

- A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.
- B. Sound Transmission Characteristics: For STC-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

#### **PART 2 - PRODUCTS**

##### **2.1 NON-LOAD-BEARING STEEL FRAMING, GENERAL**

- A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.
  - 1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal, unless otherwise indicated.
  - 2. Protective Coating: manufacturer's standard corrosion-resistant zinc coating, unless otherwise indicated.
  - 3. Anchors: Fabricated from corrosion-resistant materials with holes or loops for attaching wire hangers and capable of sustaining, without failure, a load equal to [5] times that imposed by construction as determined by testing according to ASTM E 488 by an independent testing agency.
    - a. Type: Postinstalled, expansion anchor.
  - 4. Powder-Actuated Fasteners: Suitable for application indicated, fabricated from corrosion-resistant materials with clips or other devices for attaching hangers of type indicated, and capable of sustaining, without failure, a load equal to 10 times that imposed by

construction as determined by testing according to ASTM E 1190 by an independent testing agency.

- B. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.162-inch diameter.
- C. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.0538 inch and minimum 1/2-inch- wide flanges.
  - 1. Depth: As indicated on Drawings.
- D. Furring Channels (Furring Members):
  - 1. Cold-Rolled Channels: 0.0538-inch bare-steel thickness, with minimum 1/2-inch- wide flanges, 3/4 inch deep.
  - 2. Steel Studs: ASTM C 645.
    - a. Minimum Base-Metal Thickness: As indicated on Drawings.
    - b. Depth: As indicated on Drawings.
  - 3. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch deep.
    - a. Minimum Base Metal Thickness: As indicated on Drawings.

## 2.2 STEEL FRAMING FOR FRAMED ASSEMBLIES

- A. Steel Studs and Runners: ASTM C 645.
  - 1. Minimum Base-Metal Thickness: As indicated on Drawings.
- B. Slip-Type Head Joints: Where indicated, provide one of the following:
  - 1. Single Long-Leg Runner System: ASTM C 645 top runner with 2-inch- deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top runner and with continuous bridging located within 12 inches of the top of studs to provide lateral bracing.
  - 2. Double-Runner System: ASTM C 645 top runners, inside runner with 2-inch- deep flanges in thickness not less than indicated for studs and fastened to studs, and outer runner sized to friction fit inside runner.
  - 3. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.
- C. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
  - 1. Minimum Base-Metal Thickness: 0.0312 inch.
- D. Cold-Rolled Channel Bridging: 0.0538-inch bare-steel thickness, with minimum 1/2-inch- wide flanges.
  - 1. Depth: 1-1/2 inches.
  - 2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches, 0.068-inch- thick, galvanized steel.

- E. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
  - 1. Minimum Base Metal Thickness: As indicated on Drawings.
  - 2. Depth: As indicated on Drawings.
- F. Cold-Rolled Furring Channels: 0.0538-inch bare-steel thickness, with minimum 1/2-inch- wide flanges.
  - 1. Depth: As indicated on Drawings.
  - 2. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with minimum bare-steel thickness of 0.0312 inch.
  - 3. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625-inch- diameter wire, or double strand of 0.0475-inch- diameter wire.
- G. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches, wall attachment flange of 7/8 inch, minimum bare-metal thickness of 0.0179 inch, and depth required to fit insulation thickness indicated.

## 2.3 AUXILIARY MATERIALS

- A. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.
- B. Isolation Strip at Exterior Walls: Provide the following:
  - 1. Asphalt-Saturated Organic Felt: ASTM D 226, Type I (No. 15 asphalt felt), nonperforated.
  - 2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch thick, in width to suit steel stud size.

## PART 3 - EXECUTION

### 3.1 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C 754.
  - 1. Gypsum Plaster Assemblies: Also comply with requirements in ASTM C 841 that apply to framing installation.
  - 2. Portland Cement Plaster Assemblies: Also comply with requirements in ASTM C 1063 that apply to framing installation.
  - 3. Gypsum Veneer Plaster Assemblies: Also comply with requirements in ASTM C 844 that apply to framing installation.
  - 4. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.

### 3.2 INSTALLING FRAMED ASSEMBLIES

- A. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

- B. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.
1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
  2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
    - a. Install two studs at each jamb, unless otherwise indicated.
    - b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint in finished assembly.
    - c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
  3. Other Framed Openings: Frame openings other than door openings the same as required for door openings, unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
  4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
    - a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
  5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
  6. Curved Partitions:
    - a. Bend track to uniform curve and locate straight lengths so they are tangent to arcs.
    - b. Begin and end each arc with a stud, and space intermediate studs equally along arcs. On straight lengths of not less than 2 studs at ends of arcs, place studs 6 inches o.c.
- C. Direct Furring:
1. Screw to wood framing.
  2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
- D. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

END OF SECTION 092216

**SECTION 092900**  
**GYPSUM BOARD**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. This Section includes the following:
  - 1. Interior gypsum board.
  - 2. Tile backing panels.
  - 3. Exterior glass-mat gypsum board sheathing
- B. Related work
  - 1. Specified elsewhere
    - a. Painting Section 099100.

**1.2 SUBMITTALS**

- A. Product Data/Samples
  - 1. Submit for Engineer/Architect's approval: (minimum 5 copies required)
    - a. Manufacturer's data and/or catalog sheets clearly indicating products proposed for use.
    - b. Manufacturer's recommended installation instructions for each specific installation.

**1.3 QUALITY ASSURANCE**

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.
- C. Contractor shall employ only skilled and experienced workmen/workwomen who are fully qualified in the installation of specified materials and shall provide a fully qualified superintendent or foreman who shall be present at all times during execution of this work.
- D. Application and Finishing Standards:
  - 1. Gypsum Association File 216.
  - 2. ASTM C840.

#### 1.4 DELIVERY, STORAGE, HANDLING

- A. All materials shall be delivered in their original unopened packages, properly labeled; stored and handled at job site in a manner to prevent damage in accordance with manufacturer's recommendations.
  - 1. Damaged or deteriorated materials shall not be used in the construction and shall be removed from the job site.

### PART 2 - PRODUCTS

#### 2.1 GENERAL

- A. Provide in longest lengths practicable as will result in a minimum of joints.
- B. Provide recessed or tapered edge type for single layer application and for face layer of double layer application. Use square edge type for back-up layer of double layer application.
  - 1. Provide in thickness indicated on the drawings.
- C. General: Interior gypsum board complying with ASTM C 36/C 36M or ASTM C 1396/C 1396M, as applicable to type of gypsum board indicated and whichever is more stringent.

#### 2.2 Manufacturers

- A. Acceptable Manufacturers:
  - 1. National Gypsum Company
  - 2. USG Corp.
  - 3. CertainTeed Corp.
  - 4. Georgia-Pacific Gypsum LLC

#### 2.3 Standard Gypsum Board

- A. Basis-of-Design: National Gypsum Gold Bond Brand Gypsum Board
  - 1. Panel Physical Characteristics
    - a. Core: Regular gypsum core
    - b. Surface Paper: 100 percent recycled content paper on front, back and long edges
    - c. Long Edges: Tapered
    - d. Overall thickness: As shown on drawings
    - e. Panel complies with requirements of ASTM C 1396

#### 2.4 Gold Bond Fire-Shield Gypsum Board

- 1. Panel Physical Characteristics
  - a. Type X, Panel Physical Characteristics



- b. Core: Fire-resistance rated gypsum core
- c. Surface paper: 100 percent recycled content paper on front, back and long edges
- d. Long Edges: Square
- e. Overall thickness: As shown on drawings
- f. Panel complies with Type X requirements of ASTM C 1396

## 2.5 Abuse Resistant Gypsum Board

- A. Basis-of-Design: National Gypsum Gold Bond Brand Hi-Abuse XP Gypsum Board Performance Criteria - Wall Assembly STC: 52

### 1. Panel Physical Characteristics

- a. Core: Fire-resistance rated gypsum core, with additives to enhance surface indentation resistance and impact resistance
- b. Surface paper: Abrasion resistant, 100 percent recycled content moisture/mold/mildew resistant paper on front, back and long edges
- c. Long Edges: Tapered
- d. Overall thickness: As shown on drawings
- e. Panel complies with Type X requirements of ASTM C 1396
- f. Surface Abrasion Resistance: Classification Level 3 in accordance with ASTM C 1629
- g. Indentation Resistance: Classification Level 1 in accordance with ASTM C 1629.
- h. Soft Body Impact Resistance: Classification Level 2 in accordance with ASTM C 1629
- i. Hard Body Impact Resistance: Classification Level 1 in accordance with ASTM C 1629.
- j. Mold/Mildew Resistance: score of 10 when tested in accordance with ASTM D 3273.

## 2.6 Impact Resistant Gypsum Board

- A. Basis-of-Design: National Gypsum Gold Bond Brand Hi-Impact XP Gypsum Board

- B. Performance Criteria - Wall Assembly STC: 52

### 1. Panel Physical Characteristics

- a. Core: Fire-resistance rated gypsum core, with additives to enhance mold/mildew resistance, surface indentation resistance, impact resistance and moisture and mold resistant
- b. Surface paper: Abrasion resistant, 100 percent recycled content moisture/mold/mildew resistant paper on front, back and long edges
- c. Embedded fiberglass mesh
- d. Long Edges: Tapered
- e. Overall thickness: As shown on drawings.
- f. Panel complies with Type X requirements of ASTM C 1396
- g. Surface Abrasion Resistance: Classification Level 3 in accordance with ASTM C 1629
- h. Indentation Resistance: Classification Level 1 in accordance with ASTM C 1629.
- i. Soft Body Impact Resistance: Classification Level 3 in accordance with ASTM C 1629
- j. Hard Body Impact Resistance: Classification Level 3 in accordance with ASTM C 1629.

- k. Mold/Mildew Resistance: 10 when tested in accordance with ASTM D 3273.

## 2.7 Acoustical Gypsum Board

- A. Basis-of-Design: CertainTeed SilentFX Gypsum Board
- B. Performance Criteria – Wall Assembly STC: 62

### 1. Panel Physical Characteristics

- a. Laminated noise-reducing gypsum board consisting of two layers of dense gypsum board encased in smooth, moisture and mold resistant paper facings laminated together with viscoelastic polymer noiseproofing compound. Meeting the requirements of ASTM C1766.
- b. 4. Surface Paper: 100% recycled moisture and mold resistant paper on face, back and long edges.
- c. Mold Resistance Rating:
  - 1) Score of 10 (best possible) tested in accordance with ASTM D3273
  - 2) Abuse-Resistance per ASTM C1629: Surface Abrasion – Level 1 Indentation Resistance – Level 1, Soft Body Impact – Level 1

## 2.8 Moisture Resistant XP Type Gypsum Board

- A. Basis-of-Design: National Gypsum Gold Bond Brand XP Gypsum Board

### 1. Panel Physical Characteristics

- a. Core: Mold and moisture resistant gypsum core
- b. Surface paper: 100 percent recycled content moisture/mold/mildew resistant paper on front, back, and long edges Long Edges: Tapered
- c. Overall thickness: As shown on drawings
- d. Panel complies with requirements of ASTM C 1396
- e. Mold/Mildew Resistance: 10 when tested in accordance with ASTM D 3273

## 2.9 Tile Backer Board

- A. Cementitious Backer Units:

- 1. Complying with ANSI A108.1.
- 2. Thickness: As indicated on Drawings.

## 2.9 EXTERIOR GYPSUM BOARD

- A. General: Complying with ASTM C 931/C931M or ASTM C 1396/C 1396M, with manufacturer's standard edges.
  - 1. Thickness: As indicated on drawings.
- B. Glass-Mat Gypsum Sheathing Board:

1. Complying with ASTM C 1177/C 1177M.
2. Thickness: As indicated on drawings.

## 2.10 TRIM ACCESSORIES

### A. Interior Trim: ASTM C 1047.

1. Material: Formed from zinc-coated steel not lighter than 26 ga., comply with Fed Spec. QQ-S-775, Type I, Class D or E, as approved by the Engineer/Architect.
2. Shapes:
  - a. Cornerbead.
  - b. Bullnose bead.
  - c. LC-Bead: J-shaped; exposed long flange receives joint compound.
  - d. L-Bead: L-shaped; exposed long flange receives joint compound.
  - e. U-Bead: J-shaped; exposed short flange does not receive joint compound.
  - f. Expansion (control) joint.
  - g. Curved-Edge Cornerbead: With notched or flexible flanges.

### B. Exterior Trim: ASTM C 1047.

1. Material: Hot-dip galvanized steel sheet, or rolled zinc.
2. Shapes:
  - a. Cornerbead.
  - b. LC-Bead: J-shaped; exposed long flange receives joint compound.
  - c. Expansion (Control) Joint: One-piece, rolled zinc with V-shaped slot and removable strip covering slot opening.

## 2.11 JOINT TREATMENT MATERIALS

### A. General: Comply with ASTM C 475/C 475M.

### B. Joint Tape

1. Interior Gypsum Wallboard: Paper.
2. Glass-Mat Gypsum Sheathing Board: 10-by-10 glass mesh.
3. Tile Backing Panels: As recommended by panel manufacturer.

### C. Joint Compound for Interior Gypsum Wallboard: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.

1. Prefilling: At open joints and damaged surface areas, use setting-type taping compound.
2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use drying-type, all purpose compound.
3. Fill Coat: For second coat, use drying-type, all-purpose compound.
4. Finish Coat: For third coat, use drying-type, all-purpose compound.
5. Skim Coat: For final coat of Level 5 finish, use setting-type, sandable topping compound.

### D. Joint Compound for Exterior Applications:

1. Glass-Mat Gypsum Sheathing Board: As recommended by sheathing board manufacturer.

E. Joint Compound for Tile Backing Panels:

1. Water-Resistant Gypsum Backing Board: Use setting-type taping compound and setting-type, sandable topping compound.
2. Glass-Mat, Water-Resistant Backing Panel: As recommended by backing panel manufacturer.
3. Cementitious Backer Units: As recommended by backer unit manufacturer.

2.12 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.
- B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
1. Use adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
  2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

**PART 3 - EXECUTION**

3.1 GENERAL INSTALLATION AND WORKMANSHIP

- A. Comply with all pertinent recommendations of the applicable standards and manufacturer's installation recommendations for each specific type application.
- B. Installation of all materials shall be fully qualified, experienced workmen/workwomen, skilled in application of gypsum wallboard to metal framed and/or wood framed structures and skilled in the application and finishing of joint treatment specified.
- C. Panels shall be secured to framing members with screws of proper type and size spaced maximum of 10" o.c.; or by a combination of screw attachment and adhesive as may be recommended by the manufacturer and approved by the Engineer/Architect.
- D. Wallboard for ceiling shall be installed first and shall be installed in longest lengths practicable with long dimension perpendicular to framing members and with joints staggered a minimum of two framing spaces between adjacent panel rows.
1. Where cross furring is indicated on the drawings, install wallboard with long dimension perpendicular to furring.
  2. For double layer application, reverse direction between layers.
- E. At junction of wallboard partitions with other type materials, provide continuous full height length acoustical sealant bead between wallboard edge trim and adjacent material.

- F. Neatly cut and fit wallboard to all electrical boxes and other penetrations through wallboard and provide compound filter and/or sealant bead around same to form an effective seal between wallboard surface and finishing plates.

### 3.2 APPLYING AND FINISHING PANELS, GENERAL

- A. Comply with ASTM C 840.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- C. Isolate perimeter of gypsum board applied to non-load bearing partitions at structural abutments, except floors. Provide 1/4" wide spaces at these locations, and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- D. Wood Framing: Install gypsum panels over wood framing, with floating internal corner construction. Do not attach gypsum panels across the flat grain of wide-dimension lumber, including floor joists and headers. Float gypsum panels over these members, or provide control joints to counteract wood shrinkage.

### 3.3 APPLYING TILE BACKING PANELS

- A. Cementitious Backer Units: ANSI A108.1, at areas as indicated on drawings.
- B. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

### 3.4 INSTALLING TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- B. Control Joints: Install control joints at locations indicated on drawings, and according to ASTM C 840 and in specific locations approved by Architect for visual effect.
- C. Interior Trim: Install in the following locations:
  - 1. Cornerbead: Use at outside corners.
  - 2. Bullnose Bead: Use where indicated on drawings.
  - 3. LC-Bead: Use at exposed panel edges.
  - 4. L-Bead: Use where indicated.
  - 5. U-Bead: Use at exposed panel edges.
  - 6. Curved-Edge Cornerbead: Use at curved openings.
- D. Exterior Trim: Install in the following locations:
  - 1. Cornerbead: Use at outside corners.
  - 2. LC-Bead: Use at exposed panel edges.

### 3.5 FINISHING GYPSUM BOARD

- A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
- B. Prefill open joints and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape. Tape and seal all joints and internal corners with reinforcing tape and joint compound. Apply tape and compound in strict accordance with manufacturer's directions and recommendations of the applicable standards.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below:
  - 1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
  - 2. Level 2: Panels that are substrate for tile.
  - 3. Level 3: [Where indicated on Drawings] <Insert locations>.
  - 4. Level 4: At panel surfaces that will be exposed to view, unless otherwise indicated.
    - a. Primer and its application to surfaces are specified in other Division 09 Sections.
  - 5. Level 5: Where indicated on Drawings.
    - a. Primer and its application to surfaces are specified in other Division 09 Sections.
  - 6. All taped and filled joints, filled depressions at screws, filled corner beads, and areas around electrical outlet boxes and other wall penetrations shall be expertly feathered out onto panel faces and sanded perfectly smooth, fully acceptable for final painting or other finish.
    - a. Careful attention shall be given to all internal corners and areas around electrical outlet boxes.
    - b. Joints shall be feathered out a minimum of 12" and further as necessary to render joints undetectable under finish painted surfaces.
- E. Cementitious Backer Units: Finish according to manufacturer's written instructions.
- F. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- G. Remove and replace panels that are wet, moisture damages, and mold damaged.
  - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
  - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 092900

**SECTION 093013  
CERAMIC TILING**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Base Bid:
  - 1. General Contractor provide:
    - a. Porcelain floor tile.
- B. Related Sections include the following:
  - 1. Division 07 Section "Joint Sealers" for sealing of joints in tile surfaces.

**1.2 SUBMITTALS**

- A. Product Data: Submit manufacturer's technical information and installation instructions for materials required, except bulk materials.
- B. Samples: Submit samples for verification.
  - 1. Full-size units of each type of tile, trim and accessory for each color and finish required.
  - 2. Metal edge strips in 6-inch lengths.

**1.3 QUALITY ASSURANCE**

- A. Perform Work in accordance with the 2016 TCNA Handbook.
- B. Source Limitations for Tile: Obtain all tile of same type and color or finish from one source or producer.
  - 1. Obtain tile from same production run and of consistent quality in appearance and physical properties for each contiguous area.
- C. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from a single manufacturer and each aggregate from one source or producer.
- D. Source Limitations for Other Products: Obtain each of the following products specified in this Section through one source from a single manufacturer for each product:
  - 1. Joint sealants
  - 2. Metal edge strips

1.4 PRE-INSTALLATION MEETING

- A. Section 013100 – Coordination and Meetings
- B. Convene minimum one week prior to commencing work of this section.

1.5 DELIVER, STORAGE AND HANDLING

- A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Prevent damage or contamination to materials by water, freezing, foreign matter or other causes.

1.6 PROJECT CONDITIONS

- A. Maintain environmental conditions and protect work during and after installation to comply with referenced standards and manufacturer's printed recommendations.
- B. Vent temporary heaters to exterior to prevent damage to tile installation from carbon dioxide buildup.
- C. Maintain temperatures at not less than 50°F in tiled areas during installation and for 7 days after completion, unless higher temperatures are required by referenced installation standard or manufacturer's instructions.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed, for each type, composition, color, pattern, and size indicated.
    - a. Minimum 1 full box of each color and texture.

**PART 2 - PRODUCTS**

2.1 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with requirements shown on the drawings and specified, provide Basis of Design tile products or submit a comparable product to be approved by the architect.
  - 1. Porcelain Tile:
    - a. Basis of Design: Atlas Concorde USA
    - b. American Olean Tile Co., Inc.
    - c. Dal-Tile Corp.
    - d. Crossville Inc.
    - e. Florida Tile Industries, Inc.



## 2.2 PRODUCTS, GENERAL

- A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1, "Specifications for Ceramic Tile" for types, compositions, and other characteristics indicated.
  - 1. Provide tile complying with Standard grade requirements, unless otherwise indicated.
- B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI standards referenced in "Setting and Grouting Materials" Article.
- C. Factory Blending: For tile exhibiting color variations within ranges selected during Sample submittals, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.
- D. Mounting: For factory-mounted tile, provide back- or edge-mounted tile assemblies as standard with manufacturer, unless otherwise indicated.
  - 1. Where tile is indicated for installation in wet areas, do not use back- or edge-mounted tile assemblies unless tile manufacturer specified in writing that this type of mounting is suitable for installation indicated and has a record of successful in-service performance.
- E. Factory-Applied Temporary Protective Coating: Where indicated under tile type, protect exposed surfaces of tile against adherence of mortar and grout by pre-coating with continuous film of petroleum paraffin wax, applied hot. Do not coat unexposed tile surfaces.

## 2.3 TILE PRODUCTS

- A. PORCELAIN FLOOR TILE (CT-1)
  - 1. Basis of Design Product: Atlas Concorde USA; Blaze
  - 2. Size: 29 1/2" x 59"
  - 3. Edge: Square
  - 4. Surface Finish: Matte
  - 5. Color: As indicated on drawings and schedules.

## 2.4 SETTING AND GROUTING MATERIALS

- A. Available Manufacturers:
  - 1. Basis of Design Product: MAPEI Corporation
  - 2. TEC from H.B. Fuller
  - 3. LATICRETE International Inc.
- B. Setting Material: Latex-Portland Cement Mortar (Thin Set): ANSI A118.4 or ANSI A118.15
- C. Grout: ANSI A118.6 Standard Cement Grout. Use sanded grout for joints 1/8 inch wide and larger. Use unsanded grout for joints less than 1/8 inch wide. Provide water-based colorless grout sealer; liquid applied, moisture and stain protection for existing or new Portland cement grout.

## 2.5 MISCELLANEOUS MATERIALS

- A. Trowelable Underlayments and Patching Compounds: Latex-modified, Portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.
- B. Crack Isolation membrane / waterproofing membrane: Comply with ANSI A118.12.
  - 1. Basis of Design Product: MAPEI; Mapelastic AquaDefense
- C. Metal Edge Strips: Angle or L-shape, height to match tile and setting-bed thickness.
  - 1. Basis of Design Product: Schluter Systems
    - a. CT-1 to LVT-2: Schluter RENO-TK; Color: Satin Nickel Anodized Aluminum
  - 2. Applications: Open edges floor tile, transitions between floor finishes of different heights.
- D. Temporary Protective Coating: Product that is formulated to protect exposed surfaces of tile against adherence of mortar and grout; compatible with tile, mortar, and grout products; and easily removable after grouting is completed without damaging grout or tile.
  - 1. Grout release in form of manufacturer's standard proprietary liquid coating that is specially formulate and recommended for use as temporary protective coating for tile.
- E. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

## 2.6 MIXING MORTARS AND GROUT

- A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.
- B. Add materials, water, and additives in accurate proportions
- C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile.
  - 1. Verify that substrates for setting tile are firm; dry; clean; free of oil, waxy films, and curing compounds; and within flatness tolerances required by referenced ANSI A108 Series of tile installation standards for installations indicated.

2. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed before installing tile.
3. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Remove coatings, including curing compounds and other substances that contain soap, wax, oil, or silicone, that are incompatible with tile-setting materials.
- B. Blending: For tile exhibiting color variations, use factory blended tile or blend tiles at Project site before installing.
- C. Field-Applied Temporary Protective Coating: Where indicated under tile type or needed to prevent grout from staining or adhering to exposed tile surfaces, precoat them with continuous film of temporary protective coating, taking care not to coat unexposed tile surfaces.

### 3.3 INSTALLATION, GENERAL

- A. ANSI Tile Installation Standards: Comply with parts of ANSI A108 Series "Specifications for Installation of Ceramic Tile" that apply to types of setting and grouting materials and to methods indicated in ceramic tile installation schedules.
- B. TCNA Installation Guidelines: TCNA's "Handbook for Ceramic Tile Installation." Comply with TCNA installation methods indicated in ceramic tile installation schedules.
- C. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions, unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
- D. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Grind cut edges of tile abutting trim, finish, or built-in items. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile. Sound tile after setting. Replace hollow sounding units.
- E. Where tiles that have a change in thickness are adjacent, provide lippage no greater than 1/16 inch or according to ANSI A108.02.
- F. Jointing Pattern: Lay tile as indicated on drawings. Align joints when adjoining tiles on base, walls, and trim are same size. Lay out tile work and center tile fields in both directions in each space or on each wall area, unless otherwise indicated. Adjust to minimize tile cutting. Provide uniform joint widths, unless otherwise indicated.
- G. At changes in plane and tile-to-tile control joints, use tile sealant instead of grout, with either bond breaker tape or backer rod as appropriate, to prevent three-sided bonding.
- H. Expansion Joints: Locate expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tile.

1. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants".

- I. Grout tile to comply with requirements of the following tile installation standards.

1. For ceramic tile grouts (sand-portland cement; dry-set, commercial Portland cement; and latex-portland cement grouts), comply with ANSI A108.10.
2. Cementitious backer units installed under Division 09 Section "Gypsum Board" shall comply with ANSI A108.11, and manufacturer's written instructions for type of application indicated.

### 3.4 INSTALLATION – FLOORS - MORTAR BED METHOD

- A. Interior Concrete Substrates: install in accordance with TCNA Method F122, with waterproofing/crack isolation membrane, unless otherwise indicated.
  1. Waterproofing / Crack isolation membrane: Install with base flashing and as recommended by manufacturer at all toilet and shower rooms unless otherwise indicated.
  2. Mortar Bed Thickness: ¼ inch, unless otherwise indicated.
- B. Grout Joint Widths: Install tile with minimum required grout joint widths required by the manufacturer.

### 3.5 CLEANING AND PROTECTION

- A. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
  1. Remove latex-portland cement grout residue from tile as soon as possible.
  2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions, but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.
  3. Remove temporary protective coating by method recommended by coating manufacturer that is acceptable to tile and grout manufacturer. Trap and remove coating to prevent it from clogging drains.
- B. When recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear.
- C. Before final inspection, remove protective coverings and rinse neutral cleaner from tile surfaces.

END OF SECTION 093013

## **SECTION 095123 ACOUSTICAL TILE CEILINGS**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. This Section includes acoustical tiles and concealed suspension systems for ceilings.

#### **1.2 SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Samples: For each exposed finish.
- C. Maintenance data.

#### **1.3 QUALITY ASSURANCE**

- A. Acoustical Testing Agency Qualifications: An independent testing laboratory, or an NVLAP-accredited laboratory.
- B. Fire-Test-Response Characteristics:
  - 1. Surface-Burning Characteristics: Acoustical tiles complying with ASTM E 1264 for Class A materials, when tested per ASTM E 84.
    - a. Smoke-Developed Index: 450 or less.

#### **1.4 EXTRA MATERIALS**

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Acoustical Ceiling Units: Full-size tiles equal to five percent of quantity installed.
  - 2. Suspension System Components: Quantity of each concealed grid and exposed component equal to five percent of quantity installed.

### **PART 2 - PRODUCTS**

#### **2.1 ACOUSTICAL TILE CEILINGS, GENERAL**

- A. Acoustical Tile Standard: Comply with ASTM E 1264.
- B. Metal Suspension System Standard: Comply with ASTM C 635.

- C. Attachment Devices: Size for five times the design load indicated in ASTM C 635, Table 1, "Direct Hung," unless otherwise indicated. Comply with IBC design requirements.
- D. Wire Hangers, Braces, and Ties: Zinc-coated carbon-steel wire; ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
  - 1. Size: Select wire diameter so its stress at 3 times hanger design load (ASTM C 635, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.106-inch-diameter wire.
- E. Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension system runners.
- F. Axiom Transitions, acoustical ceiling to acoustical ceiling elevation changes, straight 8", where shown on plans.

## 2.2 SUSPENSION SYSTEM

- A. Exposed grid suspension systems for interior ceilings with all standard components, main runners, cross tees, wall mouldings, splice plates, hanger wire, anchors, and other necessary accessories for 24" x 48" ceiling tile layouts (refer to reflected ceiling plan). System shall conform to requirements of ASTM C635, Intermediate Duty.
  - 1. Main Beams and Cross Tees: Double web steel, 1 1/2" height, 15/16" face dimension, metal thickness minimum .015.
  - 2. Wall moulding: Hemmed edge angle type, 15/16" x 15/16".
  - 3. Finish: Factory applied baked enamel finish for all exposed surfaces. Color: white.
  - 4. Hanger wire: Minimum No.12 galvanized.
  - 5. Armstrong "Prelude", XL Fire Guard 15/16", Exposed Tee, or Engineer/Architect approved equal.

## 2.3 LAY – IN ACOUSTICAL CEILING TILE (ACP-1)

- A. Ceiling Tile (ACP-1)
  - 1. Armstrong Cortega Second Look #2767, USG Radar Illusion Two/24 #2842, or Engineer/Architect approved equal.
  - 2. Fire Class A.
  - 3. Texture: Medium Texture
  - 4. Colors: White.
  - 5. Edge Profile: 15/16" Tegular
  - 6. Humidity resistant, Humiguard.
  - 7. Mold resistant.
  - 8. Sag resistant.
  - 9. Approximately 55% recycled.
  - 10. CAC minimum: up to 35.
  - 11. NRC: up to 55
  - 12. Light reflectance: up to 84.
  - 13. Size: 24" x 48".

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Comply with ASTM C 636 and seismic design requirements indicated, per manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."
- B. Measure each ceiling area and establish layout of acoustical tiles to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width tiles at borders.
- C. Suspend ceiling hangers from building's structural members, plumb and free from contact with insulation or other objects within ceiling plenum. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers, use trapezes or equivalent devices. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
  - 1. Do not support ceilings directly from permanent metal forms or floor deck; anchor into concrete slabs.
  - 2. Do not attach hangers to steel deck tabs or to steel roof deck.
- D. Install edge moldings and trim of type indicated at perimeter of acoustical tile ceiling area and where necessary to conceal edges of acoustical tiles. Screw attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet. Miter corners accurately and connect securely.
- E. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- F. Install acoustical tiles in coordination with suspension system and exposed moldings and trim. Place splines or suspension system flanges into kerfed edges so tile-to-tile joints are closed by double lap of material.

END OF SECTION 095123

**SECTION 096500**  
**RESILIENT FLOORING**

**PART 1 - GENERAL**

**1.1 SUMMARY**

**A. Work includes:**

1. Provide complete, in place, the resilient flooring for the project, as shown, noted, or scheduled on the drawings and as specified herein.
  - a. Refer to drawings and finish schedules for locations of work involved.
  - b. Luxury Vinyl Tile.
  - c. Resilient Base.
  - d. Resilient molding accessories.

**B. Pre installation Conference:**

1. Pre installation conference required with Architect for all floor patterns.

**1.2 SUBMITTALS**

**A. Shop Drawings:**

1. Submit for Engineer/Architect's approval: (minimum 5 copies required)

**B. Product Data/Samples:**

1. Prior to ordering materials, submit for Engineer/Architect's approval, five (5) copies of manufacturer's data or catalog sheets on all specified products together with manufacturer's recommended installation instructions.
2. Prior to ordering materials, submit for Engineer/Architect's approval, samples of the following:
  - a. Luxury Vinyl Tile.
  - b. Resilient base, cove and toeless.
  - c. Tapered reducer strips, divider strips.

**1.3 QUALITY ASSURANCE**

- A. Contractor shall employ only skilled and experienced workmen/workwomen who are fully qualified in the installation of specified materials and shall provide a fully qualified superintendent or foreman who shall be present at all times during execution of this work.
- B. In order to establish minimum quality requirements, products of certain manufacturers are listed. Products of other reputable manufacturers, which are equal in all respects to those listed, will be considered, subject to Engineer/Architect's approval.



#### 1.4 DELIVERY, STORAGE, HANDLING

- A. All materials shall be delivered in their original unopened packages, properly labeled; stored and handled at job site in a manner to prevent damage or deterioration in accordance with manufacturer's recommendations.
  - 1. Damaged or deteriorated materials shall not be used in the construction work and shall be removed from the job site.

#### 1.5 PROJECT CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive resilient products during the following time.
  - 1. 48 hours before installation
  - 2. During installation
  - 3. 48 hours after installation.
- B. Until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.
  - 1. Install resilient products after other finishing operations, including painting, have been completed.

#### 1.6 REPLACEMENT MATERIALS / EXTRA STOCK, SURPLUS MATERIAL

- A. At completion of the work, furnish and deliver to the Owner for his use in future replacement, modifications or maintenance:
  - 1. One full carton of each color or pattern of floor tile used. Make certain that tile is from same color run as the installed tile.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURER

- A. Basis-of-Design: Subject to compliance with requirements, the design is based on the product named in the "Flooring Finish Schedule" and "Wall Base Schedule" on the Drawings. Provide either the named product or a comparable product by one of the other manufacturers specified.

#### 2.2 RESILIENT BASE (RES-1)

- A. Resilient Base Standard: ASTM F 1861
  - 1. Material Requirement: Type TS (rubber, vulcanized thermoset).
  - 2. Manufacturing Method: Group 1 (solid, homogeneous).
  - 3. Style: Toeless at concrete floors, Coved elsewhere.

- B. Minimum Thickness: 1/8 inch
- C. Height: 4 inch (typical)
- D. Lengths: Coils in manufacturer's standard length.
- E. Colors and Patterns: As indicated on drawings and schedules. Provide either the named product or a comparable product by one of the other manufacturers specified.
  - 1. Basis of Design Product: Johnsonite
  - 2. Burke
  - 3. Flexco

## 2.3 LUXURY VINYL TILE (LVT-1 & LVT-2)

- A. Tile Standard: Complies with requirements for ASTM F 1066 Standard Specification for Vinyl Composition Floor Tile, Class 1 (Solid Color) and Class 2 (Through Pattern).
- B. Thickness: 0.1000-inch
- C. Colors: As indicated on drawings and schedules.
- D. Size: 18"x36" tile
- E. Refer to drawings for patterns and color locations.
- F. Manufacturer, Colors and Patterns: As indicated on the drawings and schedules. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified.
  - 1. Basis of Design Product: Armstrong World Industries, Inc.
  - 2. Congoleum Corporation
  - 3. Mannington Mills, Inc.
  - 4. Tarkett, Inc.

## 2.4 RESILIENT MOLDING ACCESSORIES

- A. Description: Carpet edge for glue-down applications, reducer strip for resilient floor covering, joiner for tile and carpet, reducer strip for resilient stair tread to sealed concrete, joiner for tile and resinous flooring, and transition strips at door openings where flooring material changes.
  - 1. LVT to CT
  - 2. LVT to SC
- B. Material: Vinyl / Rubber
- C. Colors and Patterns: As indicated on drawings and schedules.
- D. Acceptable manufacturers:
  - 1. Basis of Design Product: Johnsonite.
  - 2. Burke.

3. Flexco.

## 2.5 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, Portland cement based or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by manufacturer to suit resilient products and substrate conditions indicated.
  1. Use adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
    - a. Cove Base Adhesives: Not more than 50 g/L
    - b. Floor Adhesive: Not more than 60 g/L
- C. Stair Tread and Nose Filler: Johnsonite #930 Two-Part Epoxy Caulking Compound to fill nosing substrates that do not conform to tread contours.

## 2.6 ACCESSORIES

- A. For patching, smoothing, and leveling monolithic subfloors (concrete), provide Armstrong S-463 Level Strong cement based self-leveling compound.
- B. For sealing joints between the top of wall base or integral cove cap and irregular wall surfaces such as masonry, provide plastic filler applied according to the manufacturer's recommendations.
- C. Provide transition/reducing strips tapered to meet abutting materials.

## PART 3 - EXECUTION

### 3.1 SURFACE CONDITIONS/JOB CONDITIONS

- A. General Contractor shall turn over all floor surfaces to flooring contractor in broom-clean condition. Flooring contractor shall inspect all floors prior to installation of any materials. Correct conditions detrimental to proper installation. Do not proceed with work of this section until unsatisfactory conditions have been corrected.
- B. Verify that substrate is smooth, level, at required finish elevation, and without more than 1/8" in 10'-0" variation from level or slopes shown on the drawings.
- C. General finishing operations, including painting, should be completed and permanent heating system should be in operation prior to starting this work.
- D. Temperature of at least 70° F shall be maintained:
  1. In areas where flooring materials are stored during the 24 hour period immediately prior to installation.

2. In areas where resilient flooring is to be installed, during installation, and for 48 hours thereafter.

### 3.2 PREPARATION

- A. Rough concrete floors shall have projections and trowel marks removed to a satisfactory condition.
- B. Depressions in concrete floors shall be primed with emulsified asphalt thinned to a brushing consistency and filled with a mixture of 1 part high early strength cement, 2 parts sand, and 1 part emulsified asphalt tempered with water to a plastic mortar as dry as can be placed. Allow filler to thoroughly cure and harden before flooring is installed.
- C. Floor surfaces shall be thoroughly cleaned and dry mopped to ensure removal of all dirt, grit, or other material which would prevent bonding or which would indent flooring material.
- D. Prepare Substrates according to ASTM F 710 including the following:
  1. Moisture Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.
    - a. Perform anhydrous calcium chloride test, ASTM F 1869. Results must not exceed 5 lbs. Moisture Vapor Emission Rate per 1,000 sq. ft. in 24 hours.
  - or –
  - b. Perform relative humidity test using in situ probes, ASTM F 2170. Must not exceed 80%.
2. A pH test for alkalinity must be conducted. Results should range between 7 and 9. If the test results are not within the acceptable range of 7 to 9, the installation must not proceed until the problem has been corrected.
3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer.

### 3.3 INSTALLATION

- A. General:
  1. Verify that moisture content of concrete slabs, building air temperature, and relative humidity are within limits recommended by manufacturers of materials to be used.
  2. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on the finish surface as marked on the subfloor. Use chalk or other non-permanent marking device.
  3. Apply approved adhesives in strict accordance with the manufacturer's recommendations and install flooring only when adhesive has reached correct consistency.
  4. Butt flooring tightly to vertical surfaces, nosings, edgings, thresholds, etc.
  5. Expertly scribe around pipes and other obstructions to produce neat appearance.
  6. Extend flooring into toe spaces, door reveals, and similar spaces.
  7. Install tapered reducer strips at all exposed edges of resilient flooring.
  8. Roll flooring with minimum 100 lb. roller. Provide smooth finished floor installation, free of buckles, cracks, waves, or unsightly joints.
- B. Installing Floor Tile:

1. Install using tile from a number of open cartons to prevent noticeable color change lines.
2. Install all tile in straight line pattern unless specifically indicated otherwise on drawings.
3. Install all tile with pattern design.
4. Tile shall be installed symmetrical about center lines of rooms or areas generally but layout shall be carefully considered and modified as necessary to eliminate small or thin pieces at walls, for best overall appearance.
5. Install divider strips under doors as necessary between rooms or areas for off-setting pattern lines.
6. Refer to Floor Pattern Plan on Drawings. Verify with Engineer/Architect, layout of floor tile pattern and use of divider strips.

C. Installing Rubber Base:

1. Install base for all areas indicated in finish schedule on drawings and at all toe space of casework.
2. Install with minimum joints.
3. Furnish and install factory pre-formed exterior corners unless noted otherwise.

D. Resilient Accessory Installation:

1. Comply with manufacturer's written instructions for installing resilient accessories.
2. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of resilient floor covering that would otherwise be exposed.

3.4 ADJUSTMENTS AND CLEANING

- A. At conclusion of the work, examine entire installation. Replace all damaged tile and leave entire installation free from defects.
- B. Remove all excess adhesive from face of flooring. Thoroughly clean and remove all marks, mastic spots, etc. from floors and other surfaces.
- C. Comply with manufacturer's written instructions for cleaning and protection of resilient products.
- D. Cover resilient products until Substantial Completion.

END OF SECTION 096500

## **SECTION 099100**

### **PAINTING**

#### **PART 1 - GENERAL**

##### **1.1 SUMMARY**

- A. Work included: Provide complete, in place, the painting work for the project, as shown, noted, or scheduled on the drawings and as specified herein.
- B. Related Sections: The following sections contain requirements that relate to this section:
  - 1. Division 08 "Hollow Metal Doors and Frames" for shop priming steel doors and frames.

##### **1.2 SUBMITTALS**

- A. In accord with 013300:
  - 1. Product data:
    - a. Materials list of items proposed to be provided under this Section;
    - b. Manufacturer's specifications and other data needed to prove compliance with the specified requirements;
    - c. Two (2) Drawdowns for each color and sheen shown on drawings and schedules.

##### **1.3 RELATED WORK**

- A. Documents affecting work of this Section include, but are not necessarily limited to, General Conditions, Supplementary conditions, and Sections in Division 1 of these Specifications.
- B. Priming or priming and finishing of certain surfaces may be specified to be factory-performed or installer-performed under pertinent other Sections.

##### **1.4 QUALITY ASSURANCE**

- A. Use adequate numbers of skilled workers who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.
- B. Paint coordination:
  - 1. Provide finish coats which are compatible with the prime coats actually used.
  - 2. Review other Sections of these Specifications as required, verifying the prime coat to be used and assuring compatibility of the total coating system for the various substrata.
  - 3. Upon request, furnish information on the characteristics of the specific finish materials to assure that compatible prime coats are used.
  - 4. Provide barrier coats over noncompatible primers, or remove the primer and reprime as required.

5. Notify the Architect/Engineer in writing of anticipated problems in using the specified coating systems over prime-coatings supplied under other Sections.

## 1.5 PRODUCT STORAGE & PROTECTION

- A. Comply with pertinent provisions of Section 016600.

## 1.6 JOB CONDITIONS

- A. Do not apply solvent-thinned paints when the temperature of surfaces to be painted and the surrounding air temperatures are below 45 degrees F, unless otherwise permitted by the manufacturers' printed instructions as approved by the Architect/Engineer.
- B. Weather conditions:
  1. Do not apply paint in snow, rain, fog, or mist; or when the relative humidity exceeds 85%; or to damp or wet surfaces, unless otherwise permitted by the manufacturers' printed instructions as approved by the Architect/Engineer.
  2. Applications may be continued during inclement weather only within the temperature limits specified by the paint manufacturer as being suitable for use during application and drying periods.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Basis-of-Design: Subject to compliance with requirements, provide named product by Sherwin Williams or an APPROVED comparable product by one of the following:
  1. Benjamin Moore Paints
  2. Glidden Professional
  3. M.A.B. Paints
  4. PPG Architectural Finishes, Inc.
- B. Undercoats and thinners:
  1. Provide undercoat paint produced by the same manufacturer as the finish coat.
  2. Use only the thinners recommended by the paint manufacturer, and use only to the recommended limits.
  3. Insofar as practicable, use undercoat, finish coat, and thinner material as parts of a unified system of paint finish.

### 2.2 PAINT MATERIALS

- A. Material Compatibility: Provide block fillers, primers, and finish-coat materials that are compatible with one another and with the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
- B. Undercoats and thinners:

1. Provide undercoat paint produced by the same manufacturer as the finish coat.
  2. Use only the thinners recommended by the paint manufacturer, and use only to the recommended limits.
  3. Insofar as practicable, use undercoat, finish coat, and thinner material as parts of a unified system of paint finish.
- C. Colors: Match colors indicated by manufacturer's designations on the drawings and schedules as selected from manufacturer's full range.
1. Manufacturer's names listed in the "Wall Finish Schedule" on the drawings are for color selection only. Other manufacturers shall match color indicated.

## 2.3 APPLICATION EQUIPMENT

- A. For application of the approved paint, use only such equipment as is recommended for application of the particular paint by the manufacturer of the particular paint, and as approved by the Architect/Engineer.

## 2.4 OTHER MATERIALS

- A. Provide other materials, not specifically described but required for a complete and proper installation, as selected by the Contractor subject to the approval of the Architect/Engineer.

# PART 3 - EXECUTION

## 3.1 SURFACE CONDITIONS

- A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

## 3.2 MATERIALS PREPARATION

- A. General:
1. Mix and prepare paint materials in strict accordance with the manufacturers' recommendations as approved by the Architect/Engineer.
  2. When materials are not in use, store in tightly covered containers.
  3. Maintain containers used in storage, mixing, and application of paint in a clean condition, free from foreign materials and residue.
  4. Do not stir into the material any film which may form on the surface, but remove the film and, if necessary, strain the material before using.

## 3.3 SURFACE PREPARATION

- A. General:



1. Perform preparation and cleaning procedures in strict accordance with the paint manufacturers' recommendations as approved by the Architect/Engineer.
2. Remove removable items, which are in place and are not scheduled to receive paint finish; or provide surface-applied protection prior to surface preparation and painting operations.
3. Following completion of painting in each space or area, reinstall the removed items by using workers who are skilled in the necessary trades.
4. Clean each surface to be painted prior to applying paint or surface treatment.
5. Remove oil and grease with clean cloths and cleaning solvent of low toxicity and flash point in excess of 200 degrees F, prior to start of mechanical cleaning.

B. Preparation of all new metal surfaces to receive paint:

1. Thoroughly clean surfaces until free from dirt, oil, and grease.
2. On galvanized surfaces, use solvent for the initial cleaning, then treat the surface thoroughly with phosphoric acid etch. Remove etching solution completely before proceeding.
3. Allow to dry thoroughly before application of paint.

C. Preparation of all new drywall surfaces to receive paint:

1. Thoroughly examine surfaces prior to and again after prime coat is applied. Joints and holes shall be properly filled, feathered out and sanded perfectly smooth to prevent detection of same through specified finish paint.
  - a. Do not apply finish coats until all unsatisfactory conditions have been corrected.

D. Preparation of all new concrete block or concrete surfaces to receive paint:

1. Surfaces shall be thoroughly dry, free from dirt and dust; shall have mortar projections and splatters removed; shall have holes, cracks, and joints properly filled; mortar joints rubbed or stoned smooth; and surfaces otherwise properly prepared to receive the specified paint or special coatings.
  - a. If surfaces cannot be properly prepared, the conditions shall be reported to the General Contractor and Architect/Engineer.
  - b. Do not apply finish coats until all unsatisfactory conditions have been corrected.

### 3.4 PAINT APPLICATION

A. General:

1. Touchup shop-applied prime coats which have been damaged, and touchup bare areas prior to start of finish coats application.
2. Slightly vary the color of succeeding coats.
  - a. Do not apply additional coats until the completed coat has been inspected and approved.
  - b. Only the inspected and approved coats of paint will be considered in determining the number of coats applied.
3. Sand and dust between coats to remove defects visible to the unaided eye from a distance of five feet.

B. Drying:

1. Allow sufficient drying time between coats, modifying the period as recommended by the material manufacturer to suit adverse weather conditions.
2. Consider oil-base and oleo-resinous solvent-type paint as dry for recoating when the paint feels firm, does not deform or feel sticky under moderate pressure of the thumb, and when the application of another coat of paint does not cause lifting or loss of adhesion of the undercoat.

C. Brush applications:

1. Brush out and work the brush coats onto the surface in an even film.
2. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, and other surface imperfections will not be acceptable.

D. Spray application:

1. Except as specifically otherwise approved by the engineer/architect, confine spray application to metal framework and similar surfaces where hand brush work would be inferior.
2. Where spray application is used, apply each coat to provide the hiding equivalent of brush coats.
3. Do not double back with spray equipment to build up film thickness of two coats in one pass.

E. Miscellaneous surfaces and procedures:

1. Exposed mechanical items:
  - a. Finish electric panels, access doors, conduits, outlet boxes, grilles, registers, vents, and items of similar nature to match the adjacent wall and ceiling surfaces, or as directed by the Engineer/Architect.
  - b. Wash metal with solvent, prime, and apply two coats of latex enamel.

### 3.5 PAINTING SCHEDULE

A. Provide the following paint finishes: Refer to 3.4.A.1 concerning specified prime coats.

B. Exterior and Interior unless noted otherwise:

1. All exposed plain iron and steel.
  - a. Includes but not limited to:
    - 1) Hollow Metal Doors and Frames.
    - 2) Exposed structural and miscellaneous steel, ladders
    - 3) Exposed gas piping (interior and exterior).
  - b. Finish System:
    - 1) Sherwin Williams.

- a) First/Prime Coat: DTM Acrylic Primer/Finish.
    - b) Second and Third Coat: ProMar 200 Zero VOC Latex Semi-Gloss Enamel.
  - c. Exposed structural steel shall have shop prime coat touched up at welds, connections and abraided areas as necessary.
- 2. All exposed galvanized.
  - a. Includes but not limited to:
    - 1) Exposed galvanized mechanical piping and electrical conduit.
    - 2) Hollow Metal Doors and Frames
  - b. Finish System:
    - 1) Sherwin Williams:
      - a) First/Prime Coat: DTM Acrylic Primer/Finish.
      - b) Second and Third Coat: ProMar 200 Zero VOC Latex Semi-Gloss Enamel.
- 3. Wood Surfaces, Trim, and Finish
  - a. Finish system shall consist of three coat stain/varnish system:
    - 1) Sherwin Williams:
      - a) First Coat: Oil Stain.
      - b) Polyurethane Varnish, Gloss.
      - c) Polyurethane Varnish, Satin.
- 4. Gypsum Board areas:
  - a. Finish system:
    - 1) Sherwin Williams:
      - a) First Coat: ProMar 200 Latex Wall Primer.
      - b) Second and Third Coats: ProMar 200 Zero VOC Interior Latex Eggshell Enamel.
  - b. All walls inside toilet rooms and as noted to receive epoxy paint shall receive:
    - a) First Coat: latex primer.
    - b) Second and Third Coats: Water based catalyzed epoxy.
- 5. Interior Pre-cast Concrete/Concrete Block areas:
  - a. Finish system:
    - 1) Sherwin Williams:

- a) First Coat: PrepRite Block Filler.
    - b) Second and Third Coats: ProMar 200 Zero VOC Interior Latex Eggshell Enamel.
  - b. All walls inside toilet rooms and as noted to receive epoxy paint shall receive:
    - 1) Sherwin Williams:
      - a) First Coat: PrepRite Block Filler.
      - b) Second and Third Coats: Water based catalyzed epoxy.
- 6. Exposed pre-cast concrete roof deck and exposed metal deck/bar joists.
  - a. Finish system:
    - 1) Sherwin Williams:
      - a) First Coat: Pro Industrial Waterborne Acrylic Dryfall Eggshell

END OF SECTION 099100

## **SECTION 101420 INTERIOR SIGNAGE**

### **PART 1 GENERAL**

#### **1.1 SUMMARY**

- A. Section includes interior regulatory identification signs.

#### **1.2 SUBMITTALS**

- A. Section 013300 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate sign styles, lettering font, foreground and background colors, locations, overall dimensions of each sign.

#### **1.3 QUALITY ASSURANCE**

- A. Perform Work in accordance with State of Illinois standard.
- B. Maintain one copy of each document on site.

#### **1.4 QUALIFICATIONS**

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.

#### **1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Section 016000 - Product Requirements: Product storage and handling requirements.
- B. Package signs, labeled in name groups.
- C. Store adhesive attachment tape at ambient room temperatures.

#### **1.6 ENVIRONMENTAL REQUIREMENTS**

- A. Section 016000 - Product Requirements: Environmental conditions affecting products on site.
- B. Do not install signs when ambient temperature is lower than recommended by manufacturer.
- C. Maintain this minimum temperature during and after installation of signs.

## PART 2 PRODUCTS

### 2.1 INTERIOR SIGNS

#### A. Manufacturers:

1. Basis of Design: Inpro Corp.
2. ASI Signs
3. Substitutions: Section 016000 - Product Requirements.

#### B. Product Description: ADA Regulatory and Room ID signage.

### 2.2 COMPONENTS

#### A. Injection Molded Signs, Base Material: Rigid Vinyl - Basis of Design Product: InPro Corporation: Signscape Architectural Signage

1. Sign Colors: As indicated on drawings and schedules.
2. Panel Construction: Provide rigid vinyl panels composed of .032" thick moisture resistant, rigid vinyl sign base. Panel shall be single piece construction. Panel thicknesses shall be 1/16", 1/8" or 1/4". Maximum panel size shall be 18" x 24".
3. Size: As indicated for each sign type on drawings and schedules.
4. Edges: Square
5. Character Font: ADA Avenir
6. Character Color: Black
7. Pictograms - Raised Tactile International Symbols, including handicap accessible symbol.
8. Margins: As indicated on Drawings and Schedules
9. Messages: As indicated on Drawings and Schedules. Grade 2 Accompanying Braille

### 2.3 ACCESSORIES

#### A. Tape Adhesive: Double sided tape, permanent adhesive.

## PART 3 EXECUTION

### 3.1 EXAMINATION

#### A. Section 013000 - Administrative Requirements: Verification of existing conditions before starting work.

### 3.2 INSTALLATION

- #### A. Install signs after wall surfaces are finished, in locations indicated on Drawings and schedules.
- #### B. Position vertical center line of sign within 18 inches from strike side of door, level.

- C. Position horizontal center line of sign on wall surface between 48" min and 60" max above finished floor, level.
- D. Install all signs at the same position, relative to the strike side of the door.

END OF SECTION 101420

## SECTION 102113 TOILET COMPARTMENTS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes units as follows:
  - 1. Toilet Enclosures: Floor supported and overhead braced.
  - 2. Urinal Screens: Wall hung and post supported.

#### 1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
- C. Samples: For each exposed finish.

### PART 2 - PRODUCTS

#### 2.1 SOLID-POLYMER UNITS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Basis of Design Product: General Partitions, Series 40
  - 2. Scranton Products
  - 3. ASI Groups
  - 4. Master Building Specialties
- B. Door, Panel, and Pilaster Construction: Solid, high-density polyethylene (HDPE) panel material, meeting the requirements of NFPA 286, not less than 1 inch thick, seamless, with eased edges, and with homogenous color and pattern throughout thickness of material. *HDPE panel materials shall meet all the requirements of NFPA 286.*
  - 1. Color and Pattern: One color and pattern in each room as indicated on the drawings.
- C. Pilaster Shoes and Sleeves (Caps): Manufacturer's standard design; stainless steel.
- D. Brackets (Fittings):
  - 1. Stirrup Type: Ear or U-brackets, chrome-plated, nonferrous, cast zinc alloy (zamac) or clear anodized aluminum.
  - 2. Full-Height (Continuous) Type: Manufacturer's standard design; extruded aluminum.



- E. Heat-Sink Strip: Manufacturer's standard continuous, extruded-aluminum strip fastened to exposed bottom edges of solid-polymer components to prevent burning.

## 2.2 ACCESSORIES

- A. Hardware and Accessories: Manufacturer's standard design, heavy-duty operating hardware and accessories.
  - 1. Material: Chrome-plated, nonferrous, cast zinc alloy (zamac) or clear anodized aluminum
- B. Overhead Bracing: Manufacturer's standard continuous, extruded-aluminum head rail with antigrip profile and in manufacturer's standard finish.
- C. Support Posts for Urinal Screens: Manufacturer's standard aluminum post with floor shoe for anchoring to floor construction.
- D. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel or chrome-plated steel or brass, finished to match hardware, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use hot-dip galvanized or other rust-resistant, protective-coated steel.

## 2.3 FABRICATION

- A. Overhead-Braced Units: Provide manufacturer's standard corrosion-resistant supports, leveling mechanism, fasteners, and anchors at pilasters to suit floor conditions. Make provisions for setting and securing continuous head rail at top of each pilaster. Provide shoes at pilasters to conceal supports and leveling mechanism.
- B. Doors: Unless otherwise indicated, provide 24 inch- wide in-swinging doors for standard toilet compartments and 36 inch- wide out-swinging doors with a minimum 32 inch- wide clear opening for compartments indicated to be accessible to people with disabilities.
  - 1. Hinges: Manufacturer's continuous aluminum spring hinge..
  - 2. Latch and Keeper: Manufacturer's standard surface-mounted latch unit designed for emergency access and with combination rubber-faced door strike and keeper. Provide units that comply with accessibility requirements of authorities having jurisdiction at compartments indicated to be accessible to people with disabilities.
  - 3. Coat Hook: Manufacturer's standard combination hook and rubber-tipped bumper, sized to prevent door from hitting compartment-mounted accessories.
  - 4. Door Bumper: Manufacturer's standard rubber-tipped bumper at out-swinging.
  - 5. Door Pull: Manufacturer's standard unit at out-swinging doors that complies with accessibility requirements of authorities having jurisdiction. Provide units on both sides of doors at compartments indicated to be accessible to people with disabilities.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position with manufacturer's recommended anchoring devices.

1. Maximum Clearances:
  - a. Pilasters and Panels: ½ inch.
  - b. Panels and Walls: 1 inch.
2. Brackets: Manufacturer's continuous aluminum brackets.

### 3.2 ADJUSTING

- A. Hardware Adjustment: Adjust and lubricate hardware according to manufacturer's written instructions for proper operation. Set hinges on in-swinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on out-swinging doors to return doors to fully closed position.

END OF SECTION 102113

## **SECTION 102600**

### **WALL AND DOOR PROTECTION**

#### **PART 1 - GENERAL**

##### **1.1 SUMMARY**

- A. This Section includes the following:
  - 1. Provide wall corner guards at all outside corners of gypsum wallboard.

##### **1.2 SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Include sections, details, and attachments to other work.
- C. Samples: For each type of unit and for each color and texture required.

##### **1.3 QUALITY ASSURANCE**

- A. Fire-Test-Response Characteristics: Provide impact-resistant, plastic wall-protection units with surface-burning characteristics as determined by testing identical products per ASTM E 84, NFPA 255, or UL 723 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.

##### **1.4 DELIVERY, STORAGE, AND HANDLING**

- A. Store plastic wall-protection components for a minimum of 72 hours, or until plastic material attains a minimum room temperature of 70°F.

#### **PART 2 - PRODUCTS**

##### **2.1 MANUFACTURERS**

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  - 1. Basis-of-Design Product: The design for each impact-resistant wall-protection unit is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified.

## 2.2 MATERIALS

- A. Extruded Rigid Plastic: High-impact-resistant PVC or acrylic-modified vinyl plastic with integral color throughout.
- B. Adhesive: Type recommended by manufacturer for use with material being adhered to substrate indicated.
  - 1. Use adhesives and sealants that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
    - a. Gypsum Board and Panel Adhesives: 50 g/L.
    - b. Multipurpose Construction Adhesives: 70 g/L.
    - c. Contact Adhesive: 250 g/L.
- C. Surface-Mounted, Opaque-Plastic Corner Guards: Fabricated from PVC plastic, acrylic-modified vinyl sheet or opaque polycarbonate sheet; with formed edges; fabricated with 90- degree turn to match wall condition.
  - 1. Basis-of-Design Product: IPC Door and Wall Protection Flexible Corner Guard, or a comparable product by one of the following:
  - 2. Manufacturers:
    - a. Construction Specialties, Inc.
    - b. Korogard Wall Protection Systems; Division of RJF International Corporation.
  - 3. Wing Size: Nominal 2 by 2 inches x 9' high.
  - 4. Mounting: Adhesive.
  - 5. Color and Texture: Refer to plans for color selection.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Complete finishing operations, including painting, before installing impact-resistant wall-protection system components.
- B. Install impact-resistant wall-protection units level, plumb, and true to line without distortions. Do not use materials with chips, cracks, voids, stains, or other defects that might be visible in the finished Work.
  - 1. Provide splices, mounting hardware, anchors, and other accessories required for a complete installation.
- C. Immediately after completion of installation, clean plastic covers and accessories using a standard, ammonia-based, household cleaning agent.
- D. Remove excess adhesive using methods and materials recommended in writing by manufacturer.

END OF SECTION 102600

## **SECTION 102813 TOILET ACCESSORIES**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

**A. Work includes**

1. Provide complete, in place, the toilet accessories for the project, as shown, noted, or scheduled on the drawings and as specified herein.

#### **1.2 SUBMITTALS**

**A. Product Data/Samples**

1. Submit for Engineer/Architect's approval: (minimum 5 copies required)
  - a. Manufacturer's catalog or data sheets on all specified products together with manufacturer's recommended installation instructions.

#### **1.3 QUALITY ASSURANCE**

- A. Contractor shall employ only skilled and experienced workmen/workwomen who are fully qualified and familiar with the assembly and recommended installation procedures for specified products.**

### **PART 2 - PRODUCTS**

#### **2.1 GRAB BARS**

- A. 1-1/4" OD, Type 304 Stainless Steel, 18 gauge, smooth satin finish, concealed mounting type. Provide in lengths and configurations indicated on the drawings.**

**1. Acceptable Products**

- a. Bobrick "B-5806 Series".
- b. Bradley "832 Series".
- c. American Specialties, Inc., 3700 Series Grab Bars
- d. Approved equal.

#### **2.2 MIRRORS**

- A. No. 1 quality 1/4" plate/float glass, electrolytically copper backed, edges and back protected with shock absorbing material, heavy gauge galvanized steel back, concealed wall hangers slotted for concealed mounting with theft-resistant devices. Provide type 304 stainless steel square**

corner channel frames with polished finish. Provide mirrors in sizes noted or indicated on the drawings.

1. Acceptable products
  - a. Bradley "781 Series".
  - b. Bobrick "B-165 Series".
  - c. American Specialties, Inc., 0620 Series Mirrors
  - d. Approved equal.

## 2.3 SOAP DISPENSERS

- A. Automated Soap Dispenser: Liquid soap dispenser, with stainless steel cover and window to gauge soap level, tumbler lock.
  1. Mounting: As indicated in product listing.
  2. Minimum Capacity: As indicated in product listing.
  3. Products:
    - a. Model 0360 - Automatic Soap Dispenser - Liquid - Battery - 35 oz (1.04 L) - Surface-mounted.
    - b. Approved equal.

## 2.4 TOILET TISSUE DISPENSERS

- A. Toilet Tissue Dispenser: Surface-mounted bracket type, stainless steel, spindleless type for tension spring delivery designed to prevent theft of tissue roll.
  1. Capacity: As indicated in product listing.
  2. Products:
    - a. Model 9030 - Toilet Tissue Holder – Twin Roll – Surface Mounted

## 2.5 MISCELLANEOUS MATERIALS / ACCESSORIES

- A. Provide proper type anchoring devices for specific type wall construction or partition type involved for securing all items.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Coordinate as required with other trades to assure proper and adequate provisions in the work of those trades for interface with the work of this section, including proper wood backing in building partitions.
- B. Install each item in its proper location, firmly anchored into position, level and plumb, and in accordance with manufacturer's recommendations and proper installation templates.

END OF SECTION 102813

**SECTION 104414**  
**FIRE EXTINGUISHERS AND CABINETS**

**PART 1 - GENERAL**

1.1 SUMMARY

A. Work includes

1. Provide complete, in place, the fire extinguishers and cabinets for the project, as shown, noted, or scheduled on the drawings and as specified herein.
  - a. Refer to drawings for locations and for details of wall construction and conditions.

1.2 SUBMITTALS

A. Product Data/Samples

1. Submit for Engineer/Architect's approval: (minimum 5 copies required)
  - a. Manufacturer's catalog or data sheets on specified fire extinguishers and cabinets together with manufacturer's recommended installation instructions.

1.3 QUALITY ASSURANCE

- A. Contractor shall employ only skilled and experienced workmen/workwomen who are fully qualified and familiar with the recommended installation procedures for the specified products and the wall construction involved.

**PART 2 - PRODUCTS**

2.1 EXTINGUISHERS AND CABINETS

A. Marked "FEC-SR" on Drawings:

1. Multi-Purpose Dry Chemical Extinguisher, heavy duty steel cylinder, class A B & C fires, 10 lb. capacity, rated 4A-60BC. Provide with cabinet of cold rolled steel, white epoxy finish, semi-recessed type with 2½" trim, steel frame, duo-panel glazed door (DSA), continuous hinge, zinc plated pull handle, roller catch, for wall opening 11½" x 25" x 4".

B. Marked "FEC-SM" on Drawings:

1. Same as above, less cabinet. Provide wall mounting hardware.

C. Approved Products

1. J. L. Industries "Cosmic 10E", "Ambassador 1017D10".
2. Engineer/Architect approved equal.



- D. Provide extinguishers fully charged, ready for service, and provide all accessories required for complete installation.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Install cabinets in prepared openings in accordance with the applicable drawing details and approved submittals, and as recommended by the manufacturer.
- B. Install wall hung units using proper mounting hardware as supplied with units, for rigid installation.
- C. Mounting Heights: As detailed on the drawings, or as directed by the Engineer/Architect.

END OF SECTION 104414

## **SECTION 105113 METAL LOCKERS**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. This Section includes the following:

1. Welded Lockers.

#### **1.2 SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
1. Show base, filler panels and other accessories.
  2. Include locker identification system.
- C. Samples: For each exposed finish.
- D. Maintenance data.

#### **1.3 WARRANTY**

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal lockers that fail in materials or workmanship, excluding finish, within specified warranty period.
1. Failures include, but are not limited to, the following:
    - a. Structural failures.
    - b. Faulty operation of latches and other door hardware.
  2. Damage from deliberate destruction and vandalism is excluded.
  3. Warranty Period for Knocked-Down Metal Lockers: Two years from date of Substantial Completion.

### **PART 2 - PRODUCTS**

#### **2.1 MANUFACTURERS**

1. Basis-of-Design Product: The design for each metal locker specified is based on Debourgh Rebel Welded Economy Lockers. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified.

## 2.2 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008, Commercial Steel (CS) Type B, suitable for exposed applications.
- B. Fasteners: Zinc- or nickel-plated steel, slotless-type exposed bolt heads, and self-locking nuts or lock washers for nuts on moving parts.
- C. Anchors: Select material, type, size, and finish required for secure anchorage to each substrate.
  - 1. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.

## 2.3 WELDED LOCKERS

- A. Basis-of-Design Product: Debourgh Rebel Hallway Lockers or a comparable product of one of the following:
  - 1. Knocked-Down, Athletic Metal Lockers:
    - a. Art Metal Products, Div. of Fort Knox Storage Co.; HDV Lockers.
    - b. List Industries Inc.; HDV Lockers.
    - c. Lyon Workspace Products; Expanded Metal Lockers.
    - d. Penco Products, Inc., Subsidiary of Vesper Corporation; Invincible II Lockers.
    - e. *ASI Storage Solutions, Competitor Collection, double tier athletic lockers meeting all the requirements of these specifications shall be considered an approved equal.*
- B. Locker Arrangement: Double tier, 12" x 12" x 48" each tier.
- C. Locker Construction
  - 1. Lockers to be welded uni-body construction with exposed welds sanded smooth.
  - 2. No bolts, screws or rivets used in assembly of locker units.
  - 3. Ship lockers set-up, ready to be anchored in place in accordance with manufacturer's instructions.
- D. Body of Lockers
  - 1. Tops, Bottoms, Sides: Constructed of 18 gauge domestic Cold Rolled Steel (CRS) for maximum durability.
  - 2. Backs: Solid sheet of 20 gauge CRS welded to frames of sides and intermediate partitions.
  - 3. Shelves: Constructed of 18 gauge CRS welded to sides and intermediate partition construction. Located to provide a minimum of 15-inches clearance from top of locker.
  - 4. Tier Dividers: Full depth CRS securely welded on all four sides, to combine with tops, bottoms, sides, and intermediate partitions.
- E. Continuous Door Strike
  - 1. Tier dividers, tops and bottoms constructed to provide two-sided, continuous door strike on both hinge and latch sides for a secure, sanitary and intrusion-free locker while door is in closed position.
- F. Doors

1. Doors are 18 gauge CRS formed outer panel with double bends on both sides and a single bend on top and bottom.
- G. Door Ventilation
  1. Louvers at top and bottom of door
- H. Latching
  1. Sentry II Recessed Gravity Latch:
    - a. Door containing stainless steel cup recessed into formed door
    - b. 12 gauge steel finger lift mechanism.
    - c. Spring activated nylon slide latch enclosed in steel latch channel allows closing of door while padlock or built-in lock is in position
    - d. Rubber bumpers riveted to door stops for silent operation
- I. Hinges
  1. Continuous Slope Tops
    - a. Provide 20 gauge CRS continuous slope tops with approximately 18 degree slope. Join slope panels with splice joints and finish locker runs with 16 gauge slope top end caps
- J. Bases
  1. Z-Base
    - a. Provide 4-inch high Z-base sections from 16 gauge formed CRS. Securely fasten Z-base to floor and lockers to Z-base.
- K. Filler Panels: Manufacturer's standard fabricated from 18 gauge solid steel finished to match lockers.
- L. Finish:
  1. Finish to be baked powder coat with a minimum 2-3 mil thickness.
- M. Color: Urban Dusk
- N. Accessories:
  1. Hooks
    - a. Hooks to be heavy duty forged steel with ball ends and zinc plated.
    - b. Provide one double ceiling hook in each locker opening.
  2. Numbering
    - a. Furnish each locker with black anodized laser-etched aluminum number plate.
    - b. Locate number plate near center of each door.
    - c. Owner to furnish numbering sequence.

- O. Finish: Baked enamel or powder coat.
  - 1. Color: As selected by Architect from manufacturer's full range.

## 2.4 FABRICATION

- A. General: Fabricate metal lockers square, rigid, and without warp; with metal faces flat and free of dents or distortion. Make exposed metal edges free of sharp edges and burrs, and safe to touch.
  - 1. Form body panels, doors, shelves, and accessories from one-piece steel sheet, unless otherwise indicated.
  - 2. Provide fasteners, filler plates, supports, clips, and closures as required for a complete installation.
- B. Unit Principle: Fabricate each metal locker with an individual **[door and]** frame; individual top, bottom, and back; and common intermediate uprights separating compartments.
- C. Hooks: Manufacturer's standard ball-pointed type, aluminum or steel; zinc plated.
- D. Identification Plates: Manufacturer's standard etched, embossed, or stamped **aluminum** plates; with numbers and letters at least 3/8 inch high.
- E. Continuous Base: Formed into channel or Z profile for stiffness, and fabricated in lengths as long as practicable to enclose base and base ends of metal lockers; finished to match lockers.
- F. Filler Panels: Fabricated in an unequal leg angle shape; finished to match lockers. Provide slip joint filler angle formed to receive filler panel.
- G. Finished End Panels: Designed for concealing unused penetrations and fasteners, except for perimeter fasteners, at exposed ends of nonrecessed metal lockers; finished to match lockers.

## 2.5 STEEL SHEET FINISHES

- A. Powder-Coat Finish: Immediately after cleaning and pretreating, electrostatically apply manufacturer's standard baked-polymer thermosetting powder finish. Comply with resin manufacturer's written instructions for application, baking, and minimum dry film thickness.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. General: Install level, plumb, and true; shim as required, using concealed shims.
  - 1. Anchor locker runs at ends and at intervals recommended by manufacturer, but not more than 36 inches o.c. Install anchors through backup reinforcing plates, channels, or blocking as required to prevent metal distortion, using concealed fasteners.
  - 2. Anchor single rows of metal lockers to walls near top and bottom of lockers.

- B. Equipment and Accessories: Fit exposed connections of trim, fillers, and closures accurately together to form tight, hairline joints, with concealed fasteners and splice plates.
1. Attach hooks with at least two fasteners.
  2. Attach door locks on doors using security-type fasteners.
  3. Identification Plates: Attach plates to each locker door, near top, centered, with at least two aluminum rivets.
  4. Attach filler panels with concealed fasteners.
  5. Attach finished end panels with fasteners only at perimeter to conceal exposed ends of nonrecessed metal lockers.
- C. Clean, lubricate, and adjust hardware. Adjust doors and latches to operate easily without binding. Verify that integral locking devices operate properly.

END OF SECTION 105113

**SECTION 123200**  
**MANUFACTURED WOOD CASEWORK**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
  - 1. Plastic-laminate-faced wood cabinets of stock design.
  - 2. Solid-surface countertop and window sills.

**1.2 SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
- C. Samples: For cabinet finishes and for each type of top material indicated.

**1.3 DEFINITIONS**

- A. MDF: Medium-density fiberboard.
- B. PL: Plastic Laminate
- C. RCB: Rubber Cove Base

**1.4 QUALITY ASSURANCE**

- A. Quality Standard: Unless otherwise indicated, comply with requirements for modular cabinets in AWI's "Architectural Woodwork Quality Standards."
- B. Product Designations: Drawings indicate sizes, configurations, and finish material of manufactured wood casework by referencing designated manufacturer's catalog numbers. Other manufacturers' casework of similar sizes and door and drawer configurations, of same finish material, and complying with the Specifications may be considered. Refer to Division 01 Section "Product Requirements."

**1.5 WARRANTY**

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of manufactured wood casework that fails in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Delamination of components or other failures of glue bond.

- b. Warping of components.
  - c. Failure of operating hardware.
  - d. Deterioration of finishes.
- 2. Warranty Period: 3 years from date of Substantial Completion.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Plastic-Laminate-Faced Manufactured Casework:
    - a. CampbellRhea; a Sagas International company.
    - b. TMI Systems, Corp.
    - c. Stevens Industries, Inc.

### **2.2 MATERIALS, GENERAL**

- A. Low-Emitting Materials: Provide manufactured wood casework, including countertops, made with adhesives and composite wood products containing no urea formaldehyde.
- B. Maximum Moisture Content for Lumber: 7 percent for hardwood and 12 percent for softwood.
- C. Hardwood Plywood: HPVA HP-1, either veneer core or particleboard core unless otherwise indicated.
- D. Softwood Plywood: DOC PS 1.
- E. Particleboard: ANSI A208.1, Grade M-2.
- F. Medium-Density Fiberboard: ANSI A208.2, Grade 130.
- G. Hardboard: AHA A135.4, Class 1 Tempered.
- H. Plastic Laminate: High-pressure decorative laminate complying with NEMA LD 3.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Basis of Design: Wilsonart International; Div. of Premark International, Inc.
- I. Solid-Surfacing Material: Homogeneous solid sheets of filled plastic resin complying with ISSFA-2.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Basis of Design: Wilsonart International; Div. of Premark International, Inc.



- b. Avonite Surfaces; Aristech Acrylics LLC.
    - c. E. I. du Pont de Nemours and Company.
    - d. Formica Corporation.
    - e. Nevamar Company, LLC; Decorative Products Div.
  - J. Thermoset Decorative Panels: Particleboard or Medium-Density Fiberboard finished with thermally fused, melamine-impregnated decorative paper complying with LMA SAT-1.
  - K. Edgebanding for Plastic Laminate: Plastic laminate adjacent surfaces Rigid PVC extrusions, through matching color with satin finish, 2 mm thick at doors and drawer fronts. Color to match adjacent surface as closely as possible.
  - L. Edgebanding for Thermoset Decorative Panels: PVC or polyester edge banding complying with LMA EDG-1 and matching thermoset decorative panels.
- 2.3 CABINET MATERIALS
- A. Exposed Cabinet Materials:
    - 1. Plastic Laminate: Grade VGS.
  - B. Semiexposed Cabinet Materials:
    - 1. Plastic Laminate: Grade VGS.
      - a. Provide plastic laminate for semiexposed surfaces unless otherwise indicated.
      - b. Provide plastic laminate for interior faces of doors and drawer fronts.
    - 2. Thermoset Decorative Panels: Provide thermoset decorative panels for semiexposed surfaces unless otherwise indicated.
- 2.4 DESIGN, COLOR, AND FINISH
- A. Design: Provide manufactured wood casework of the following design:
    - 1. Flush overlay with dark bronze finished wire pulls.
  - B. Wood Colors and Finishes: As selected by Architect from casework manufacturer's full range.
  - C. Thermoset Decorative Panel Colors, Patterns, and Finishes: As selected by Architect from casework manufacturer's full range].
  - D. Plastic-Laminate Colors, Patterns, and Finishes: As indicated on drawings and schedules.
  - E. PVC Edgebanding Color: As selected from casework manufacturer's full range.
  - F. Solid-Surfacing Material Colors and Patterns: As indicated on drawings and schedules.

## 2.5 CASEWORK HARDWARE

- A. Hardware, General: Unless otherwise indicated, provide manufacturer's standard dark bronze satin-finish, commercial-quality, heavy-duty hardware.
  - 1. Use threaded metal or plastic inserts with machine screws for fastening to particleboard except where hardware is through-bolted from back side.
- B. Frameless Concealed Hinges: BHMA A156.9, Type B01602, self-closing.
- C. Door/Drawer Pulls: Back-mounted, solid brass rod style, 4 inches long, 5/16 inch in diameter, dark bronze satin finish.
- D. Door Catches: Dual, self-aligning, permanent magnet catch.
- E. Drawer Slides: BHMA A156.9, Type B05091.
  - 1. Box Drawer Slides: Grade 1.
  - 2. File Drawer Slides: Grade 1HD-100.
  - 3. Pencil Drawer Slides: Grade 1.
- F. Drawer and Hinged Door Locks: Cylindrical (cam) type, 5-pin tumbler, complying with BHMA A156.11, Grade 1.

## PART 3 - EXECUTION

### 3.1 CASEWORK INSTALLATION

- A. Install level, plumb, and true; shim as required, using concealed shims. Where manufactured wood casework abuts other finished work, apply filler strips and scribe for accurate fit, with fasteners concealed where practical.
- B. Base Cabinets: Set cabinets straight, level, and plumb. Adjust sub-tops within 1/16 inch of a single plane. Fasten cabinets to masonry or framing, wood blocking, or reinforcements in walls and partitions with fasteners spaced 24 inches o.c. Bolt adjacent cabinets together with joints flush, tight, and uniform. Align similar adjoining doors and drawers to a tolerance of 1/16 inch.
- C. Wall Cabinets: Hang cabinets straight, level, and plumb. Adjust fronts and bottoms within 1/16 inch of a single plane. Fasten to hanging strips, masonry, or framing, blocking, or reinforcements in walls or partitions. Align similar adjoining doors to a tolerance of 1/16 inch.
- D. Adjust casework and hardware so doors and drawers operate smoothly without warp or bind. Lubricate operating hardware as recommended by manufacturer.

### 3.2 CLEANING AND PROTECTING

- A. Clean finished surfaces, touch up as required, and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect.
- B. Protection: Provide 6-mil plastic or other suitable water-resistant covering over countertop surfaces. Tape to underside of countertop at a minimum of 48 inches o.c. Remove protection at Substantial Completion.

END OF SECTION 123200

**SECTION 123553  
LABORATORY CASEWORK**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
  - 1. Wood laboratory casework.
  - 2. Filler and closure panels.
  - 3. Laboratory countertops.
  - 4. Epoxy sinks.
  - 5. Safety Storage Cabinets.

**1.2 RELATED SECTIONS**

- 1. For fittings, faucets, goosenecks and other plumbing fittings see Division 22 specifications.

**1.3 SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For laboratory casework. Include plans, elevations, sections, details, and attachments to other work.
- C. Samples: For each type of cabinet finish.
- D. Product Test Reports for Countertop Surface Material: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating compliance of laboratory countertop surface materials with requirements specified for chemical and physical resistance.

**1.4 QUALITY ASSURANCE**

- A. Source Limitations: Obtain laboratory casework from single source from single manufacturer unless otherwise indicated.
- B. Casework Product Standard: Comply with SEFA 8, "Laboratory Furniture - Casework, Shelving and Tables - Recommended Practices."
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Preinstallation Conference: Conduct conference at Project site.

## PART 2 - PRODUCTS

### 2.1 WOOD CABINET MATERIALS

#### A. General:

1. Certified Wood Materials: Provide cabinets with not less than 70 percent of wood products obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."
2. Adhesives: Do not use adhesives that contain urea formaldehyde.
3. Composite Wood Products: Do not use products that contain urea formaldehyde.
4. Edgebanding for Wood-Veneered Construction: Wood veneer of same species as face veneer.
  - a. Colors: As indicated on drawings and schedules.

#### B. Exposed Materials:

1. General: Provide materials that are selected and arranged for compatible grain and color.
2. Wood Species: See drawings.
3. Plywood: Hardwood plywood. Grade A exposed faces at least 1/50 inch thick. Provide backs of same species as faces.
  - a. Face Veneer Cut: Plain sliced.
4. Solid Wood: Clear hardwood lumber.

#### C. Semiexposed Materials:

1. Solid Wood: Sound hardwood lumber of same species as exposed solid wood.
2. Plywood: Hardwood plywood of same species as exposed plywood. Grade C faces.
3. Provide solid wood or hardwood plywood for semiexposed surfaces unless otherwise indicated.

### 2.2 AUXILIARY CABINET MATERIALS

- A. Glass for Glazed Doors: Clear tempered glass complying with ASTM C 1048, Kind FT, Condition A, Type I, Class 1, Quality-Q3; not less than 5.0 mm thick.

### 2.3 COUNTERTOP MATERIALS

- A. Epoxy: Factory-molded, modified epoxy-resin formulation with smooth, nonspecular finish.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Durcon Company (The).
  - b. Epoxyn Products.
  - c. Laboratory Tops, Inc.
  - d. Prime industries, inc.

2. Physical Properties:

- a. Flexural Strength: Not less than 10,000 psi.
- b. Modulus of Elasticity: Not less than 2,000,000 psi.
- c. Hardness (Rockwell M): Not less than 100.
- d. Water Absorption (24 Hours): Not more than 0.02 percent.
- e. Heat Distortion Point: Not less than 260°F.

3. Chemical Resistance: Epoxy-resin material has the following ratings when tested with indicated reagents according to NEMA LD 3, Test Procedure 3.4.5:

- a. No Effect: Acetic acid (98 percent), acetone, ammonium hydroxide (28 percent), benzene, carbon tetrachloride, dimethyl formamide, ethyl acetate, ethyl alcohol, ethyl ether, methyl alcohol, nitric acid (70 percent), phenol, sulfuric acid (60 percent), and toluene.
- b. Slight Effect: Chromic acid (60 percent) and sodium hydroxide (50 percent).

4. Color: Black.

2.4 WOOD CABINETS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Advanced Lab Concepts, Inc.
2. CampbellRhea.
3. CiF Furniture Ltd.
4. Collegedale Casework, LLC.
5. Diversified Woodcrafts, Inc.
6. Fisher Hamilton L.L.C.
7. Keur Industries, Inc.
8. Kewaunee Scientific Corporation; Laboratory Products Group.
9. Laboratory Design & Supply.
10. Leonard Peterson & Company, Inc.
11. Sheldon Laboratory Systems.
12. South Texas Woodmill, Inc.
13. Terrill Manufacturing Company.

B. Design: Reveal overlay with square edges.

1. Provide  $\frac{1}{8}$  inch reveals between doors and drawers that are adjacent.

C. Grain Direction:

1. Vertical on doors, horizontal on drawer fronts.
2. Lengthwise on face frame members.
3. Vertical on end panels.
4. Side to side on bottoms and tops of units.
5. Vertical on knee-space panels.
6. Horizontal on aprons and table frames.

D. Veneer Matching:

1. Provide veneers for each cabinet from a single flitch, book or slip and running matched.
  - a. Provide continuous matching of adjacent drawer fronts within each cabinet.

- E. Filler and Closure Panels: Provide where indicated and as needed to close spaces between cabinets and walls, ceilings, and indicated equipment. Fabricate from same material and with same finish as adjacent exposed cabinet surfaces unless otherwise indicated.

## 2.5 WOOD FINISH

- A. Preparation: Sand after assembling for uniform smoothness at least equivalent to that produced by 220-grit sanding and without machine marks, cross sanding, or other surface blemishes.
- B. Staining: Remove fibers and dust and apply stain to exposed and semiexposed surfaces as necessary to match approved Samples.
  1. Stain Color: As selected by Architect from manufacturer's full range.
- C. Chemical-Resistant Finish: Apply laboratory casework manufacturer's standard two-coat, chemical-resistant, transparent finish. Sand and wipe clean between coats. Topcoat(s) may be omitted on concealed surfaces.
  1. Chemical and Physical Resistance of Finish System: Finish complies with acceptance levels of cabinet surface finish tests in SEFA 8. Acceptance level for chemical spot test shall be no more than four Level 3 conditions.

## 2.6 HARDWARE

- A. General: Provide laboratory casework manufacturer's standard, commercial-quality, heavy-duty hardware.
- B. Hinges: Epoxy-coated steel, 5-knuckle hinges with antifriction bearings and rounded tips.
- C. Hinged Door and Drawer Pulls: Epoxy-coated steel back-mounted pulls.
- D. Sliding Door Pulls: Epoxy-coated steel recessed flush pulls.
- E. Door Catches: Dual, self-aligning, permanent magnet catches.
- F. Adjustable Shelf Supports for Wood Cabinets: Powder-coated steel shelf rests complying with BHMA A156.9, Type B04013.

## 2.7 COUNTERTOPS

- A. Countertops, General: Provide units with smooth surfaces in uniform plane free of defects. Make exposed edges and corners straight and uniformly beveled. Provide front and end overhang of 1 inch.
- B. Epoxy Countertops:

1. Countertop Fabrication: Fabricate with factory cutouts for sinks, holes for service fittings and accessories, and with butt joints assembled with epoxy adhesive and concealed metal splines.
  - a. Countertop Configuration: Flat,  $\frac{3}{4}$  inch thick, with rounded edge and corners, and with drip groove and applied backsplash.

## 2.8 SINKS AND DRAINS

### A. Sinks

1. Molded Epoxy Resin Sinks.

## 2.9 SAFETY CABINETS (PROVIDE A TOTAL OF 4)

- A. Safety cabinets, General: Provide Basis of Design CampbellRhea Corporation 8846 Stackable Combination Flammable/ Corrosive Storage Cabinet.
  - a. Capacity: Flammable 8, 1 gallon bottles; Corrosive 10; 2.5 liter bottles
  - b. Or provide similar product approved by architect.

## PART 3 - EXECUTION

### 3.1 INSTALLATION OF CABINETS

- A. Comply with installation requirements in SEFA 2.3. Install level, plumb, and true; shim as required, using concealed shims. Where laboratory casework abuts other finished work, apply filler strips and scribe for accurate fit, with fasteners concealed where practical.
- B. Base Cabinets: Fasten cabinets to utility-space framing, partition framing, wood blocking, or reinforcements in partitions with fasteners spaced not more than 24 inches o.c. Bolt adjacent cabinets together with joints flush, tight, and uniform.
  1. Where base cabinets are installed away from walls, fasten to floor at toe space at not more than 24 inches o.c. and at sides of cabinets with not less than 2 fasteners per side.
- C. Wall Cabinets: Fasten to hanging strips, masonry, partition framing, blocking, or reinforcements in partitions. Fasten each cabinet through back, near top, at not less than 24 inches o.c.
- D. Install hardware uniformly and precisely. Set hinges snug and flat in mortises.
- E. Adjust laboratory casework and hardware so doors and drawers align and operate smoothly without warp or bind and contact points meet accurately. Lubricate operating hardware as recommended by manufacturer.



### 3.2 INSTALLATION OF COUNTERTOPS

- A. Comply with installation requirements in SEFA 2.3. Abut top and edge surfaces in one true plane with flush hairline joints and with internal supports placed to prevent deflection. Locate joints only where shown on Shop Drawings.
- B. Field Jointing: Where possible, make in same manner as shop-made joints using dowels, splines, fasteners, adhesives, and sealants recommended by manufacturer. Prepare edges in shop for field-made joints.
  - 1. Use concealed clamping devices for field-made joints in plastic-laminate countertops. Locate clamping devices within 6 inches of front and back edges and at intervals not exceeding 24 inches. Tighten according to manufacturer's written instructions to exert a uniform heavy pressure at joints.
- C. Fastening:
  - 1. Secure epoxy countertops to cabinets with epoxy cement, applied at each corner and along perimeter edges at not more than 48 inches o.c.
  - 2. Where necessary to penetrate countertops with fasteners, countersink heads approximately  $\frac{1}{8}$  inch and plug hole flush with material equal to countertop in chemical resistance, hardness, and appearance.
- D. Seal unfinished edges and cutouts in plastic-laminate countertops with heavy coat of polyurethane varnish.
- E. Provide scribe moldings for closures at junctures of countertop, curb, and splash with walls as recommended by manufacturer for materials involved. Match materials and finish to adjacent laboratory casework. Use chemical-resistant, permanently elastic sealing compound where recommended by manufacturer.
- F. Carefully dress joints smooth, remove surface scratches, and clean entire surface.

### 3.3 INSTALLATION OF SINKS

- A. Comply with installation requirements in SEFA 2.3.
- B. Use procedures and products recommended by sink and countertop manufacturers.

### 3.4 INSTALLATION OF SERVICE FITTINGS

- A. Comply with requirements in Divisions 22 and 26 Sections for installing water and laboratory gas service fittings and electrical devices.
- B. Install fittings according to Shop Drawings, installation requirements in SEFA 2.3, and manufacturer's written instructions. Set bases and flanges of sink- and countertop-mounted fittings in sealant recommended by manufacturer of sink or countertop material. Securely anchor fittings to laboratory casework unless otherwise indicated.

3.5 CLEANING AND PROTECTING

- A. Clean finished surfaces, touch up as required, and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect.
- B. Protect countertop surfaces during construction with 6-mil plastic or other suitable water-resistant covering. Tape to underside of countertop at a minimum of 48 inches o.c.

END OF SECTION 123553

## SECTION 211000 WATER BASED FIRE SUPPRESSION SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes the following fire-suppression piping inside the building:
  - 1. Wet-pipe sprinkler systems.

#### 1.3 SUBMITTALS

- A. Product Data: For the following:
  - 1. Piping materials including sprinkler specialty fittings.
  - 2. Pipe hangers and supports.
  - 3. Valves, including listed fire-protection valves, unlisted general-duty valves, and specialty valves and trim.
  - 4. Sprinklers, escutcheons, and guards. Include sprinkler flow characteristics, mounting, finish, and other pertinent data.
  - 5. Fire department connections, including type; number, size, and arrangement of inlets; caps and chains; size and direction of outlet; escutcheon and marking; and finish.
  - 6. Alarm devices, including electrical data.
  - 7. Backflow preventer. Include pressure drop chart, and dimensioned drawing
- B. Fire-hydrant flow test report.
- C. Approved Sprinkler Piping Drawings: Design drawings, prepared according to NFPA 13, bearing the stamped approval of the authorities having jurisdiction, including hydraulic calculations.
  - 1. Design drawings shall include the complete overhead sprinkler system and all other potential construction interferences: HVAC diffusers, light fixtures, structural steel, etc
  - 2. Design drawing shall include a plan showing the location of underground connections, control valves, and related items
  - 3. Design drawings shall include any details and section necessary to clarify the design.
  - 4. Design drawings shall be stamped by the professional engineer retained by the Installer and described in the Quality Assurance section of this Specification.
  - 5. Design drawings shall show the location of all alarm devices to be connected to the Fire Detection and Alarm System.
- D. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include ["Contractor's Material and Test Certificate for Aboveground Piping"](#) and ["Contractor's Material and Test Certificate for Underground Piping."](#)

1. Two (2) completed copies are to be provided to the Engineer
  2. One (1) completed copy shall be provided to the authority having jurisdiction
- E. Operation Manual: Provide three (3) hard copies in separate binders and an electronic copy. Include the following:
1. Copy of product data
  2. Copy of fire hydrant test report
  3. Copy of Sprinkler Piping Diagrams
  4. Copy of Contractor's Material and Test Certificate for Aboveground Piping
  5. Copy of final letter of acceptance from authority having jurisdiction
  6. Schedule and description of required maintenance activities
- F. Provide two (2) copies of the final letter of acceptance from the authority having jurisdiction after the system has been completely installed, tested, and accepted.

#### 1.4 SYSTEM DESCRIPTIONS

- A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.
- B. The proposed sprinkler system shall be designed to meet NFPA 13 requirements without the use of a fire pump.

#### 1.5 PERFORMANCE REQUIREMENTS

- A. Standard Piping System Component Working Pressure: Listed for at least 175 psig.
- B. Fire-suppression sprinkler system design shall be approved by authorities having jurisdiction.
1. Sprinkler Occupancy Hazard Classifications: As shown on the Drawings in accordance with applicable NFPA standards and subject to the approval of the authorities having jurisdiction.
  2. Minimum Density Sprinkler Piping Design: As shown on the Drawings in accordance with applicable NFPA standards and subject to the approval of the authorities having jurisdiction.
  3. Maximum Protection Area per Sprinkler: According to applicable NFPA standards and UL listing requirements, unless otherwise indicated.
  4. Total Combined Hose-Stream Demand Requirement: According to applicable NFPA standards, unless otherwise indicated:
- C. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
- D. Seismic Performance: Fire-suppression piping shall be capable of withstanding the effects of earthquake motions determined according to NFPA 13.

## 1.6 QUALITY ASSURANCE

### A. Installer Qualifications:

1. Installer's responsibilities include designing, fabricating, and installing fire-suppression systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test performed by the installer.
  - a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer licensed in the state which the project is located.
  - b. Installer shall be a company specializing in the installation of Fire Protection Systems with a minimum of three (3) years experience.

### B. Perform work in accordance with the Fire Rating Bureau having jurisdiction, the applicable NFPA Standard listed below, and Factory Mutual Standards.

1. NFPA Standards: Fire-suppression-system equipment, specialties, accessories, installation, and testing shall comply with NFPA 13, "Installation of Sprinkler Systems."

### C. Equipment and Components shall bear FM label or marking.

## 1.7 COORDINATION

- A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.
- B. Coordinate alarm, trouble and supervisory signals originating at equipment supplied under this Section with the fire detection and alarm system.

## 1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  1. Sprinkler Cabinets: Finished, wall-mounting, steel cabinet with hinged cover, with space for number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler on Project. Location of cabinet(s) shall be coordinated with Engineer.

## PART 2 - PRODUCTS

### 2.1 STEEL PIPE AND FITTINGS

- A. Threaded-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, hot-dip galvanized where indicated and/or required with factory- or field-formed threaded ends.
  1. Cast-Iron Threaded Flanges: ASME B16.1.

2. Malleable-Iron Threaded Fittings: ASME B16.3.
  3. Steel Threaded Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, seamless steel pipe hot-dip galvanized where indicated and/or required. Include ends matching joining method.
  4. Steel Threaded Couplings: ASTM A 865 hot-dip galvanized-steel pipe where indicated and/or required.
- B. Grooved-End, Schedule 10 Steel Pipe: ASTM A 135 or ASTM A 795, Schedule 10 in NPS 5 and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10; with factory- or field-formed, roll-grooved ends.
- a. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.
  - b. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, prelubricated rubber gasket listed for use with housing, and steel bolts and nuts.

## 2.2 SPRINKLER SPECIALTY FITTINGS

- A. Sprinkler specialty fittings shall be UL listed or FMG approved, with 175-psig minimum working-pressure rating, and made of materials compatible with piping.
- B. Sprinkler Drain and Alarm Test Fittings: Cast- or ductile-iron body; with threaded or locking-lug inlet and outlet, test valve, and orifice and sight glass.
- C. Sprinkler Inspector's Test Fitting: Cast- or ductile-iron housing with threaded inlet and drain outlet and sight glass.

## 2.3 LISTED FIRE-PROTECTION VALVES

- A. Valves shall be UL listed or FMG approved, with 175-psig minimum pressure rating.
- A. Ball Valves: Comply with UL 1091, except with ball instead of disc.
1. NPS 2 and smaller: Bronze body with ends matching connecting piping.
- B. Butterfly Valves: UL 1091.
1. NPS 2-1/2 and Larger: Bronze, cast-iron, or ductile-iron body; with flanged or grooved ends.
- C. Check Valves NPS 2 and Larger: UL 312, swing type, cast-iron body with flanged or grooved ends.
- D. Indicating Valves: UL 1091, with integral indicating device and ends matching connecting piping.
1. Indicator: Electrical, 115-V ac, prewired, single-circuit, supervisory switch.
  2. NPS 2 and Smaller: Ball or butterfly valve with bronze body and ends matching connecting piping.

3. NPS 2-1/2 and Larger: Butterfly valve with cast- or ductile-iron body; with flanged or grooved ends.

## 2.4 UNLISTED GENERAL-DUTY VALVES

- A. Ball Valves NPS 2 and Smaller: MSS SP-110, 2-piece copper-alloy body with chrome-plated brass ball, 600-psig minimum CWP rating, blowout-proof stem, and ends matching connecting piping.
- B. Check Valves NPS 2 and Smaller: MSS SP-80, Type 4, Class 125 minimum, swing type with bronze body, nonmetallic disc, and ends matching connecting piping.

## 2.5 SPRINKLERS

- A. Sprinklers shall be UL listed or FMG approved, with 175-psig minimum pressure rating.
- B. Automatic Sprinklers: With heat-responsive element complying with the following:
  1. UL 199, for nonresidential applications.
  2. UL 1767, for early-suppression, fast-response applications.
- C. Sprinkler Types and Categories: Nominal 1/2-inch orifice for "Ordinary" temperature classification rating, unless otherwise indicated or required by application.
- D. Sprinkler types, features, and options as follows:
  1. Concealed ceiling sprinklers, including cover plate.
  2. Extended-coverage sprinklers.
  3. [Flush ceiling sprinklers](#), including escutcheon.
  4. Pendent sprinklers.
  5. Pendent, dry-type sprinklers.
  6. Quick-response sprinklers.
  7. Sidewall sprinklers.
  8. Sidewall, dry-type sprinklers.
  9. Upright sprinklers.
- E. Sprinkler Finishes: Chrome plated and bronze.
- F. Special Coatings: Wax.
- G. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
  1. Sidewall Mounting: Chrome-plated steel, one piece, flat.
- H. Sprinkler Guards: Wire-cage type, including fastening device for attaching to sprinkler.

## 2.6 FIRE DEPARTMENT CONNECTIONS

- A. Wall-Type, Fire Department Connection: UL 405, 175-psig minimum pressure rating; with corrosion-resistant-metal body with brass inlets, brass wall escutcheon plate, brass lugged caps with gaskets and brass chains, and brass lugged swivel connections. Include inlets with threads according to NFPA 1963 and matching local fire department sizes and threads, outlet with pipe threads, extension pipe nipples, check devices or clappers for inlets, and escutcheon plate with marking similar to "AUTO SPKR."

1. Type: Flush with two inlets and square or rectangular escutcheon plate.
2. Finish: Rough chrome plate

## 2.7 ALARM DEVICES

- A. Alarm-device types shall match piping and equipment connections.
- B. Water-Flow Indicator: UL 346, electrical-supervision, paddle-operated-type, water-flow detector with 250-psig pressure rating and designed for horizontal or vertical installation. Include two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
- C. Valve Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled valve is in other than fully open position.

## 2.8 PRESSURE GAGES

- A. Description: UL 393, 3-1/2- to 4-1/2-inch diameter, dial pressure gage with range of 0 to 250 psig.
  1. Water System Piping: Include caption "WATER" on dial face.

## 2.9 BACKFLOW PREVENTERS

- A. Reduced-Pressure-Principle Backflow Preventers:
  1. Standard: ASSE 1013 or AWWA C511.
  2. Operation: Continuous-pressure applications.
  3. Pressure Loss at Design Flow Rate: <Insert psig> or less.
  4. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved or stainless steel for NPS 2-1/2 and larger.
  5. End Connections: Matching connecting piping for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
  6. Configuration: Designed for horizontal, straight through flow.
  7. Backflow preventer shall be fully supported independent of connecting piping.
  8. Accessories:
    - a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; OS&Y gate type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.
    - b. Air-Gap Fitting: ASME A112.1.2, matching backflow preventer connection.

## 2.10 VALVE SEALS, TAGS, CHARTS, AND NAMEPLATES

- A. Seals: Brass cross-linked chain, all brass padlocks, and two keys for each manually operated shutoff valve required to be sealed in the open position.



- B. Signs: Provide identification signs of standard design, fastened securely at designated locations in accordance with NFPA 13.
- C. Tags: Provide 2" diameter brass tags, stamped with designation numbers, secured with 12 gauge copper wire to spindle of each valves.
- D. Charts:
  - 1. Provide two copies of the approved "As-Built" sprinkler system diagram and valve chart, giving designated number, function, and location of each valve. Scale of diagram shall be such that it can be easily read.
  - 2. Place one copy behind a clear plastic cover with aluminum frame and locate where directed by the Engineer. Provide the second copy to the Owner.
  - 3. Provide sign below frame: "Sprinkler System Diagram"
- E. Nameplates: Provide permanently marked weatherproof metal or rigid plastic sign secured with corrosion-resistant chain at the base of all risers within the facility. Nameplate shall include the following information:
  - 1. Location of the design area or areas
  - 2. Discharge densities over the design area or areas
  - 3. Required flow and residual pressure demand at the base of the riser
  - 4. Occupancy classification or commodity classification and maximum permitted storage height and configuration
  - 5. Hose stream allowance included in addition to the sprinkler demand
  - 6. Name of the installing contractor.

## 2.11 JOINING MATERIALS

- A. Pipe Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
  - 1. AWWA C110, rubber, flat face, 1/8 inch thick unless otherwise indicated, and full-face, unless otherwise indicated
  - 2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

## 2.12 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
  - 1. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
  - 2. Pressure Plates: Stainless steel. Include two for each sealing element.
  - 3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

## 2.13 SLEEVES

- A. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- B. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

## 2.14 ESCHUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe and an OD that completely covers opening.
- B. One-Piece, Stamped-Steel Type: With set screw and chrome-plated finish.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in Part 1 "Quality Assurance" Article.
- B. Report test results promptly and in writing.
- C. Fire-hydrant flow data provided within this Specification or the Drawings is provided only for preliminary planning purposes and shall NOT be used as the basis for final design calculations for the system and does not relieve the installer of the requirement to perform a fire hydrant flow test.

### 3.2 PIPING APPLICATIONS, GENERAL

- A. Flanges, flanged fittings, unions, nipples, and transition and special fittings with finish and pressure ratings same as or higher than system's pressure rating may be used in aboveground applications, unless otherwise indicated.
- B. Piping between Fire Department Connections and Check Valves: Galvanized, standard-weight steel pipe with grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.

### 3.3 SPRINKLER SYSTEM PIPING APPLICATIONS

- A. Standard-Pressure, Wet-Pipe Sprinkler System, 175-psig Maximum Working Pressure:
  - 1. NPS 2 and smaller: Threaded-end, black, standard-weight steel pipe; cast- or malleable-iron threaded fittings; and threaded joints; or grooved-end, black or galvanized.
  - 2. NPS 2-1/2 to NPS 6: Grooved-end, black, Schedule 10 steel pipe; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.

### 3.4 VALVE APPLICATIONS

- A. Where specific valve types are not indicated, the following requirements apply:
  - 1. Listed Fire-Protection Valves: UL listed and FMG approved for applications where required by NFPA 13.
    - a. Shutoff Duty: Use butterfly or gate valves.

2. Unlisted General-Duty Valves: For applications where UL-listed and FMG-approved valves are not required by NFPA 13.

- a. Shutoff Duty: Use ball, butterfly, or gate valves.
- b. Throttling Duty: Use ball or globe valves.

### 3.5 WATER SUPPLY

- A. Connect fire-suppression piping to either the water-service entrance piping or the interior water distribution piping as indicated on the Drawings.
- B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories as needed or indicated on the water supply connection detail.

### 3.6 PIPING INSTALLATION

- A. Locations and Arrangements: Where locations, elevations, or piping schematics are provided on the Drawing, the piping shall be installed as indicated, as far as practical. Bring to the attention of the Engineer any requested or required deviations. Where specific location and arrangement information is not provided:
  1. In areas having ceilings, conceal all pipes.
  2. In storage and service areas, pipe may be exposed but hold to the minimum practicable distance below the ceiling.
- B. Do NOT install piping within the attic or any other un-heated spaces.
- C. Do NOT install piping within exterior walls.
- D. Install piping at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping free of sags and bends.
- H. Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- I. Install unions adjacent to each valve in pipes NPS 2 and smaller. Unions are not required on flanged devices or in piping installations using grooved joints.
- J. Install flanges or flange adapters on valves, apparatus, and equipment having NPS 2-1/2 and larger connections. Flanges are not required in piping installations using grooved joints except for valves, apparatus, and equipment specifically required to utilize a flange connection.
- K. In areas where a future ceiling may be installed, 1 inch minimum outlets shall be provided with hexagonal bushings to accommodate sprinklers attached directly to the branch line to allow for future system modifications. All areas where the distance from the floor to the bottom of the lowest structural member is 15 feet or less shall be considered an area where a future ceiling may be installed unless indicated otherwise by the Engineer in writing.

- L. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, sized and located according to NFPA 13.
- M. Install sprinkler piping with drains for complete system drainage.
- N. Install ball drip valves to drain piping between fire department connections and check valves. Drain to floor drain or outside building.
- O. Install alarm devices in piping systems.
- P. Hangers and Supports: Comply with NFPA 13 for hanger materials.
- Q. Earthquake Protection: Install piping according to NFPA 13 to protect from earthquake damage.
- R. Install pressure gages on riser or feed main and at each sprinkler test connection. Include pressure gages with connection not less than NPS ¼ and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.
- S. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
  - 1. New Piping:
    - a. Exposed Piping at Wall and Ceiling Penetrations: One-piece, stamped-steel
- T. Sleeves are not required for core-drilled holes.
- U. Install sleeves for pipes passing through interior concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
  - 1. Cut sleeves to length for mounting flush with both surfaces.
    - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
  - 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
  - 3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
    - a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
  - 4. Except for underground wall penetrations, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint.
- V. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
  - 1. Install steel pipe for sleeves smaller than 6 inches in diameter.
  - 2. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

- W. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
  - 1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- X. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.
- Y. Fill wet-pipe sprinkler system piping with water.

### 3.7 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints: Comply with NFPA 13 for pipe thickness and threads. Do not thread pipe smaller than NPS 8 with wall thickness less than Schedule 40. Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- D. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- E. Grooved Joints: Assemble joints with listed coupling and gasket, lubricant, and bolts.
  - 1. Steel Pipe: Roll-groove piping as indicated. Use grooved-end fittings and rigid, grooved-end-pipe couplings, unless otherwise indicated.

### 3.8 VALVE INSTALLATION

- A. Install listed fire-protection valves, unlisted general-duty valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.
  - 1. Provide identifications tag on each valve.
  - 2. Install permanent identification signs indicating portion of system controlled by each shutoff valve.
  - 3. Install valve seals for all manual shutoff valves required to be sealed in the open position.

### 3.9 SPRINKLER APPLICATIONS

- A. Sprinkler types indicated on Drawings shall be used when provided. Where specific types are not indicated, use the following sprinkler types:

1. Rooms without Ceilings: Upright sprinklers.
2. Rooms with Suspended Ceilings: Flush sprinklers.
3. Wall Mounting: Sidewall sprinklers.
4. Spaces Subject to Freezing: Pendent or Sidewall, dry sprinklers.
5. Special Applications: Extended-coverage and quick-response sprinklers when necessitated by occupancy.
6. Sprinkler Finishes:
  - a. Upright, Pendent, and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.
  - b. Flush Sprinklers: Bright chrome, with painted white escutcheon.
7. Sprinkler Protection: Provide wire cage guards on sprinklers subject to physical damage.

### 3.10 SPRINKLER INSTALLATION

- A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels and tiles.
- B. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing. Use dry-type sprinklers with water supply from heated space.

### 3.11 FIRE DEPARTMENT CONNECTION INSTALLATION

- A. Install wall-type, fire department connections in vertical wall.
- B. Install ball drip valve at each check valve for fire department connection.

### 3.12 LABELING AND IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

### 3.13 FIELD TEST REPORTS AND CERTIFICATES

- A. Complete the "Contractor's Material and Test Certificate for Aboveground Piping".
  1. Contractor to fill out all sections of the certificate. "NA" shall be entered in any sections not pertaining to the project.
  2. Contact Engineer at least 48 hours prior to the proposed tests
  3. Provide copies to Engineer and authority having jurisdiction as described in Part 1 of this section.

### 3.14 CLEANING AND PROTECTION

- A. Clean dirt and debris from sprinklers.
- B. Remove and replace sprinklers with paint other than factory finish.
- C. Protect sprinklers from damage until Substantial Completion.

END OF SECTION 211000

## SECTION 220500 COMMON WORK RESULTS FOR PLUMBING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes the following:
  - 1. Piping materials and installation instructions common to most piping systems.
  - 2. Dielectric fittings.
  - 3. Mechanical sleeve seals.
  - 4. Sleeves.
  - 5. Escutcheons.
  - 6. Grout.
  - 7. Equipment installation requirements common to equipment sections.
  - 8. Concrete bases.
  - 9. Supports and anchorages.

#### 1.2 SUBMITTALS

- A. Shop Drawings – Prior to purchase, submit for Engineer/Architect's review complete shop drawings for the following:
  - 1. Plumbing fixtures and specialties.
- B. Welding Certificates.

#### 1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than plumbing and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, and spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and plumbing equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.



#### 1.4 QUALITY ASSURANCE

- A. Standards: Any procedure, material or operation specified by reference to applicable standards or codes shall comply with the current or most recent edition. In conflicts between listed standards, the more stringent shall govern.
  - 1. Applicable Standards:
    - a. Illinois State Plumbing Code, latest edition
    - b. Local plumbing code
    - c. National Fuel Gas Code, latest edition
- B. Contractor shall obtain all necessary permits and arrange for all inspections required by State or Local authorities.
- C. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- D. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
  - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
  - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- E. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.
- F. Materials must be new, in first class condition. Work must be done by trained, experienced, skilled journeyman (woman) under an approved full time supervisor, with every possible precaution taken by contractor to assure safety of all persons of all categories.

#### 1.5 GUARANTEE

- A. Each entire overall installation, including every special item, device, and part and every specialized system shall be fully guaranteed from standpoint of satisfactory performance, safety, workmanship and material for one year after formal written acceptance by Engineer/Architect, any unsuitable, unsatisfactory, noisy, ineffective, defective, improperly sized or applied equipment or material, or unacceptable workmanship shall be quickly replaced or modified during guarantee period or any extension thereof, as directed and as approved by Engineer/Architect in writing.
- B. Individual items and systems shall be guaranteed for the same period in addition to the above regardless of any limitations of manufacturer's guarantee period.

## **PART 2 - PRODUCTS**

### **2.1 PIPE, TUBE, AND FITTINGS**

- A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

### **2.2 JOINING MATERIALS**

- A. Refer to individual Division 22 piping Sections for special joining materials.

### **2.3 DIELECTRIC FITTINGS**

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
- E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
- F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

### **2.4 MECHANICAL SLEEVE SEALS**

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
- B. Sealing Elements: EPDM or NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
- C. Pressure Plates: Carbon steel. Include two for each sealing element.
- D. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

### **2.5 SLEEVES**

- A. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

- B. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- C. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
  - 1. Underdeck Clamp: Clamping ring with set screws.
- D. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
- E. PVC Pipe: ASTM D 1785, Schedule 40.
- F. Molded PE: Reusable, PE, tapered-cup shaped and smooth-outer surface with nailing flange for attaching to wooden forms.

## 2.6 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type: With set screw.
  - 1. Finish: Polished chrome-plated and rough brass.
- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
  - 1. Finish: Polished chrome-plated and rough brass.

## 2.7 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
  - 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
  - 2. Design Mix: 5000-psi, 28-day compressive strength.
  - 3. Packaging: Premixed and factory packaged.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Quantities Required and Clarifications:
  - 1. Contractor shall determine quantities required from drawings and job conditions except that where specifications call for specific quantities, these quantities shall also govern. If

there if conflict between quantities called for on drawings and in specifications, greater quantity shall govern.

2. Where an item is specified by a manufacturer's number, such number is for general information only, and shall be modified by any additional data, size, etc., which may be shown and/or specified. Where there is conflict between number and other data, it shall be contractor's responsibility to request clarification from Engineer/Architect.
3. Where clarification is required for any purpose, including discrepancies within written specifications on drawings, or between them, it shall be contractor's responsibility to request such clarification from Engineer/Architect at least 7 days before Bids are due and in all cases subsequent interpretations or clarifications made by Engineer/Architect shall be final.

B. Identification:

1. Every piece of equipment, disconnect, etc. which does not have an identifying name plate shall be stenciled to identify its use, by means of the abbreviations used in these specifications. Stencil shall be painted in approved colors, with letters at least 1/4" high. Stencil shall be located as approved by the Engineer/Architect. At contractor's option, tags may be riveted or screwed to equipment, in place of stencils.

C. Cleaning:

1. Piping, conduit, equipment, devices, etc. shall be thoroughly cleaned before being offered for acceptance.
2. The following shall be thoroughly cleaned, or finished out, or blown out before installation is offered for acceptance.  
Plumbing equipment, fixtures, devices, etc.
3. Labels, stickers, temporary protection, etc. shall be removed and work shall be provided contractor without increase in contract price.

D. Permits, Fees, Enlargements, Extensions, Etc.:

1. Contractor shall secure and pay for all licenses, assessments, permits; shall pay for inspections required by county, state, and local utilities; and shall replace new or present paving etc. as approved by Engineer/Architect and all governmental bodies having jurisdiction. All without increase in contract price.

E. Verification of Points of Connection:

1. Before submitting his bid, contractor shall visit site to verify all exposed, concealed, and buried points of connection as to locations, flow, size, type, depth, pressure, elevation, operating characteristics, etc., including but not limited to the following:
  - a. Water service and shut-offs.
  - b. Sanitary sewer connections.
  - c. Storm sewer connections.
2. If contractor finds that any present point or points of connection to existing facilities are incorrectly shown on plans or incorrectly specified, he (she) shall notify Engineer/Architect in writing at least 7 days before bids are due to be submitted. Engineer/Architect will issue as addendum to all contractors, calling their attention to revised point or points of connection.
3. If contractor fails to notify Engineer/Architect in writing as outlined above, it will be assumed that his bid includes everything required to provide proper connections to all

present points of connections as they actually exist and will pay for all relocations, replacements, additional runs and extensions, without increase in contract price.

### 3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for exposed penetrations of walls, ceilings, and floors.
- M. Install sleeves for pipes passing through concrete and masonry walls, and concrete floor and roof slabs.
- N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
  - 1. Install steel pipe for sleeves smaller than 6 inches in diameter.
  - 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
  - 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

- O. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
  - 1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
- Q. Verify final equipment locations for roughing-in.
- R. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

### 3.3 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402, for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
5. PVC Nonpressure Piping: Join according to ASTM D 2855.
6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.

J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

L. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.

1. Plain-End Pipe and Fittings: Use butt fusion.
2. Plain-End Pipe and Socket Fittings: Use socket fusion.

M. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

### 3.4 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

### 3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

### 3.6 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
  - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
  - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
  - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
  - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
  - 6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
  - 7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

### 3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

### 3.8 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor plumbing materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

### 3.9 GROUTING

- A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.



- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

### 3.10 EXCAVATION AND BACKFILLING

- A. Depth of bury of cover over exterior underground construction shall not be less than the following, unless otherwise noted or required.
  - 1. Sewers: 4'-0".
  - 2. Water pipes : 4'-0" .
- B. Contractor shall do excavation required to install his (her) work, including pockets as required for fittings, etc., and after same are in place and tested and approved, he (she) shall replace drives, curbs and remove surplus earth and debris from the premises as directed by Architect. Backfill under structures or pavement and within 5'-0" of same shall be thoroughly compacted aggregate. After installing pipe, backfill with compacted aggregate to 95% standard proctor density in 8" maximum lifts. Sand may be used for bedding the pipe, but shall be free of debris, rock, concrete, etc. and settled with water in layers as directed by Engineer/Architect. No materials except clean sand shall be placed within 6" of any pipe, sewer, conduit, cable or metal part.
- C. Excessive excavations, excavations required to reach undisturbed soil, lower trenches, etc., shall be filled with thoroughly compacted small sized gravel to provide adequate bedding and support. Lines shall be bedded on materials at least 2" thick.
- D. No trenches shall be filled until work has been inspected and approved by Engineer/Architect.

### 3.11 PRESSURE TESTS

- A. Test shall be applied in Engineer/Architect's presence to all equipment, valves, devices, and piping, in groups or sections as work progresses. Unless otherwise noted, tests shall be made with water, after piping and equipment have been completely vented. Pressure shall be maintained for at least four hours without drop or visible leak. If leaks appear, they shall be repaired by replacing defective material or workmanship (peining, swaging or caulking will not be permitted), refill system with water, completely vented, and repeat test as often as necessary to show no drop in 2 hours. After tests, systems shall be completely drained. Precautions shall be taken to prevent freezing of test water and to protect or remove devices or equipment, or parts thereof, controls, gauges, thermometers, etc. which may be harmed by test pressures. Tests shall be made before painted and before covering.
- B. Piping etc., shall be tested to at least 125 psi.
- C. After pressure test, each complete system, piping and equipment shall be tested for complete drainage by opening unions, caps, plugs, faucets, or hose valves at low points. If system does not drain completely, piping shall be regraded and/or drain points added until complete drainage is demonstrated to Engineer/Architect. Systems shall be left dry in freezing weather.

END OF SECTION 220500

## **SECTION 220519**

### **METERS AND GAGES FOR PLUMBING PIPING**

#### **PART 1 - GENERAL**

##### **1.1 SUMMARY**

- A. Section Includes:
  - 1. Thermometers.
  - 2. Gages.

##### **1.2 SUBMITTALS**

- A. Product Data: For each type of product indicated.

#### **PART 2 - PRODUCTS**

##### **2.1 METAL-CASE, LIQUID-IN-GLASS THERMOMETERS**

- A. Manufacturers: Subject to compliance with requirements, [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Palmer - Wahl Instruments Inc.
  - 2. Terice, H. O. Co.
  - 3. Weiss Instruments, Inc.
  - 4. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
- B. Case: Die-cast aluminum or brass, 7-inches long.
- C. Tube: Red or blue reading, organic liquid filled, with magnifying lens.
- D. Tube Background: Satin-faced, nonreflective aluminum with permanently etched scale markings.
- E. Window: Glass.
- F. Connector: Adjustable type, 360 degrees with locking device.
- G. Stem: Copper-plated steel, aluminum, or brass for thermowell installation and of length to suit installation.
- H. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

## 2.2 THERMOWELLS

- A. Manufacturers: Same as manufacturer of thermometer being used.
- B. Description: Pressure-tight, socket-type metal fitting made for insertion into piping and of type, diameter, and length required to hold thermometer.

## 2.3 PRESSURE GAGES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. AMETEK, Inc.; U.S. Gauge Div.
  - 2. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
  - 3. Ernst Gage Co.
  - 4. Eugene Ernst Products Co.
  - 5. KOBOLD Instruments, Inc.
  - 6. Marsh Bellofram.
  - 7. Miljoco Corp.
  - 8. Noshok, Inc.
  - 9. Palmer - Wahl Instruments Inc.
  - 10. REO TEMP Instrument Corporation.
  - 11. Trerice, H. O. Co.
  - 12. Weiss Instruments, Inc.
  - 13. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
  - 14. WIKA Instrument Corporation.
  - 15. Winters Instruments.
- B. Direct-Mounting, Dial-Type Pressure Gages: Indicating-dial type complying with ASME B40.100.
  - 1. Case: Liquid-filled, cast aluminum, 4-1/2-inch diameter.
  - 2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
  - 3. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.
  - 4. Movement: Mechanical, with link to pressure element and connection to pointer.
  - 5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
  - 6. Pointer: Red metal.
  - 7. Window: Glass.
  - 8. Ring: Metal.
  - 9. Accuracy: Grade B, plus or minus 2 percent of middle half scale.
  - 10. Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure.
  - 11. Range for Fluids under Pressure: Two times operating pressure.
- C. Pressure-Gage Fittings:
  - 1. Valves: NPS 1/4 brass or stainless-steel needle type.
  - 2. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

### **PART 3 - EXECUTION**

#### **3.1 THERMOMETER APPLICATIONS**

- A. Install thermometers in the outlet of each domestic, hot-water storage tank.
- B. Provide the following temperature ranges for thermometers:
  - 1. Domestic Hot Water: 30 to 180 deg F, with 2-degree scale divisions.
  - 2. Domestic Cold Water: 0 to 100 deg F, with 2-degree scale divisions.

#### **3.2 GAGE APPLICATIONS**

- A. Install dry-case-type pressure gages for discharge of each pressure-reducing valve.
- B. Install pressure gages at suction and discharge of each pump.

#### **3.3 INSTALLATIONS**

- A. Install direct-mounting thermometers and adjust vertical and tilted positions.
- B. Install thermowells with socket extending 1/3 the diameter into pipe and in vertical position in piping tees where thermometers are indicated.
- C. Install direct-mounting pressure gages in piping tees with pressure gage located on pipe at most readable position.
- D. Install needle-valve and snubber fitting in piping for each pressure gage.
- E. Install thermometers and gages adjacent to machines and equipment to allow service and maintenance for thermometers, gages, machines, and equipment.
- F. Adjust faces of thermometers and gages to proper angle for best visibility.

END OF SECTION 220519

**SECTION 220523**  
**GENERAL DUTY VALVES FOR PLUMBING PIPING**

**PART 1 - GENERAL**

1.1 SUMMARY

A. Section Includes:

1. Brass ball valves.
2. Bronze ball valves.
3. Bronze swing check valves.

B. Related Sections:

1. Division 22 plumbing piping Sections for specialty valves applicable to those Sections only.
2. Division 22 Section "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

1.2 SUBMITTALS

A. Product Data: For each type of valve indicated.

1.3 QUALITY ASSURANCE

- A. ASME Compliance: ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
- B. NSF Compliance: NSF 61 for valve materials for potable-water service.

**PART 2 - PRODUCTS**

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Refer to valve schedule articles for applications of valves.
- B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- C. Valve Sizes: Same as upstream piping unless otherwise indicated.
- D. Valve Actuator Types:
  1. Handlever: For quarter-turn valves NPS 6 and smaller.
- E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:

1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

F. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Solder Joint: With sockets according to ASME B16.18.
3. Threaded: With threads according to ASME B1.20.1.

## 2.2 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Lead-Free, Bronze Ball Valves with Bronze Trim: Lead-Free

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. American Valve, Inc.
  - b. Conbraco Industries, Inc.; Apollo Valves.
  - c. Crane Co.; Crane Valve Group; Crane Valves.
  - d. Hammond Valve.
  - e. Lance Valves; a division of Advanced Thermal Systems, Inc.
  - f. Legend Valve.
  - g. Milwaukee Valve Company.
  - h. NIBCO INC.
  - i. Red-White Valve Corporation.
  - j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
  - a. Standard: MSS SP-110.
  - b. SWP Rating: 150 psig.
  - c. CWP Rating: 400 psig minimum.
  - d. Body Design: Two piece.
  - e. Body Material: Bronze.
  - f. Ends: Threaded or Soldered.
  - g. Seats: PTFE or TFE.
  - h. Stem: Bronze.
  - i. Ball: Chrome-plated brass.
  - j. Port: Full.

## 2.3 BRONZE SWING CHECK VALVES

A. Class 125, Bronze Swing Check Valves with Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. American Valve, Inc.
  - b. Crane Co.; Crane Valve Group; Crane Valves.
  - c. Crane Co.; Crane Valve Group; Jenkins Valves.
  - d. Crane Co.; Crane Valve Group; Stockham Division.
  - e. Hammond Valve.

- f. Kitz Corporation.
- g. Milwaukee Valve Company.
- h. NIBCO INC.
- i. Powell Valves.
- j. Red-White Valve Corporation.
- k. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

- a. Standard: MSS SP-80, Type 3.
- b. CWP Rating: 200 psig.
- c. Body Design: Horizontal flow.
- d. Body Material: ASTM B 62, bronze.
- e. Ends: Threaded or Soldered
- f. Disc: Bronze.

### **PART 3 - EXECUTION**

#### **3.1 VALVE INSTALLATION**

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.

#### **3.2 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS**

- A. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.
- B. Select valves with the following end connections:
  - 1. For Copper Tubing, NPS 4 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.

#### **3.3 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE**

- A. Pipe NPS 4 and Smaller:
  - 1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
  - 2. Ball Valves: Two piece, full port, brass or bronze with brass trim.
  - 3. Bronze Swing Check Valves: Class 125, bronze disc.

END OF SECTION 220523

**SECTION 220529**  
**HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. This Section includes the following:
  - 1. Steel pipe hangers and supports.
  - 2. Trapeze pipe hangers.
  - 3. Metal framing systems.
  - 4. Thermal-hanger shield inserts.
  - 5. Fastener systems.
  - 6. Equipment supports.

**1.2 SUBMITTALS**

- A. Product Data: For the following:
  - 1. Steel pipe hangers and supports.
  - 2. Thermal-hanger shield inserts.
  - 3. Powder-actuated fastener systems.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
  - 1. Trapeze pipe hangers. Include Product Data for components.
  - 2. Metal framing systems. Include Product Data for components.
  - 3. Equipment supports.
- C. Welding certificates.

**1.3 DEFINITIONS**

- A. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

**1.4 PERFORMANCE REQUIREMENTS**

- A. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.



## 1.5 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
  - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

### 2.2 STEEL PIPE HANGERS AND SUPPORTS

- A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
- B. Manufacturers:
  - 1. AAA Technology & Specialties Co., Inc.
  - 2. Bergen-Power Pipe Supports.
  - 3. B-Line Systems, Inc.; a division of Cooper Industries.
  - 4. Carpenter & Paterson, Inc.
  - 5. Empire Industries, Inc.
  - 6. ERICO/Michigan Hanger Co.
  - 7. Globe Pipe Hanger Products, Inc.
  - 8. Grinnell Corp.
  - 9. GS Metals Corp.
  - 10. National Pipe Hanger Corporation.
  - 11. PHD Manufacturing, Inc.
  - 12. PHS Industries, Inc.
  - 13. Piping Technology & Products, Inc.
  - 14. Tolco Inc.
- C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.
- E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

## 2.3 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

## 2.4 METAL FRAMING SYSTEMS

- A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
- B. Manufacturers:
1. B-Line Systems, Inc.; a division of Cooper Industries.
  2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
  3. GS Metals Corp.
  4. Power-Strut Div.; Tyco International, Ltd.
  5. Thomas & Betts Corporation.
  6. Tolco Inc.
  7. Unistrut Corp.; Tyco International, Ltd.
- C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

## 2.5 THERMAL-HANGER SHIELD INSERTS

- A. Description: 100-psig- minimum, compressive-strength insulation insert encased in sheet metal shield.
- B. Manufacturers:
1. Carpenter & Paterson, Inc.
  2. ERICO/Michigan Hanger Co.
  3. PHS Industries, Inc.
  4. Pipe Shields, Inc.
  5. Rilco Manufacturing Company, Inc.
  6. Value Engineered Products, Inc.
- C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass with vapor barrier.
- D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.
- E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- G. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

## 2.6 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
  - 1. Manufacturers:
    - a. Hilti, Inc.
    - b. ITW Ramset/Red Head.
    - c. Masterset Fastening Systems, Inc.
    - d. MKT Fastening, LLC.
    - e. Powers Fasteners.
- B. Mechanical-Expansion Anchors: Insert-wedge-type stainless steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
  - 1. Manufacturers:
    - a. B-Line Systems, Inc.; a division of Cooper Industries.
    - b. Empire Industries, Inc.
    - c. Hilti, Inc.
    - d. ITW Ramset/Red Head.
    - e. MKT Fastening, LLC.
    - f. Powers Fasteners.

## 2.7 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

## 2.8 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
  - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
  - 2. Design Mix: 5000-psi, 28-day compressive strength.

## PART 3 - EXECUTION

### 3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.

- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use padded hangers for piping that is subject to scratching.
- F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
  - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.
  - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
  - 4. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
  - 5. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
  - 6. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
  - 7. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
  - 8. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
- G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
  - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
- H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
  - 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
- I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
  - 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
  - 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.

4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
  5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
  6. C-Clamps (MSS Type 23): For structural shapes.
  7. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    - a. Light (MSS Type 31): 750 lb.
    - b. Medium (MSS Type 32): 1500 lb.
    - c. Heavy (MSS Type 33): 3000 lb.
  8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
  9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
- J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
  2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
  3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
  2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
  3. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
- L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.
- M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
- N. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.
- 3.2 HANGER AND SUPPORT INSTALLATION
- A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
  2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
- D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation:
1. Install powder-actuated fasteners in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
  2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- G. Piping Hanger Spacing:

| Pipe Size | Distance From Sleeve<br>In Wall, End, Offset Or Corner to Hanger<br>(Max.) | Hanger Spacing<br>(Max.) |
|-----------|----------------------------------------------------------------------------|--------------------------|
| Up to 1¼" | 2'-0"                                                                      | 8'-0"                    |
| 1½ , 2"   | 3'-0"                                                                      | 10'-0"                   |
| 2½" & Up  | 3'-0"                                                                      | 12'-0"                   |

- H. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- I. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- J. Install lateral bracing with pipe hangers and supports to prevent swaying.
- K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- L. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.
- N. Insulated Piping: Comply with the following:
1. Attach clamps and spacers to piping.

- a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
  - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
  - c. Do not exceed pipe stress limits according to ASME B31.9 for building services piping.
2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
4. Shield Dimensions for Pipe: Not less than the following:
  - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
  - b. NPS 4: 12 inches long and 0.06 inch thick.
  - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
  - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
  - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
5. Pipes NPS 8 and Larger: Include wood inserts.
6. Insert Material: Length at least as long as protective shield.
7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

### 3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make smooth bearing surface.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

### 3.4 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
  1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  2. Obtain fusion without undercut or overlap.
  3. Remove welding flux immediately.
  4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

### 3.5 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

### 3.6 PAINTING

- A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
  - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 220529



**SECTION 220553**  
**IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
1. Equipment labels.
  2. Warning signs and labels.
  3. Pipe labels.

**1.2 SUBMITTALS**

- A. Product Data: For each type of product indicated.

**PART 2 - PRODUCTS**

**2.1 EQUIPMENT LABELS**

- A. Metal Labels for Equipment:
1. Material and Thickness: Brass, 0.032-inch Stainless steel, 0.025-inch Aluminum, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
  2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
  3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
  4. Fasteners: Stainless-steel rivets or self-tapping screws.
  5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Plastic Labels for Equipment:
1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
  2. Letter Color: Black.
  3. Background Color: White.
  4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
  5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
  6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
  7. Fasteners: Stainless-steel rivets or self-tapping screws.

8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

- C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
- D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

## 2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: Black.
- C. Background Color: Yellow.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information, plus emergency notification instructions.

## 2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
  - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
  - 2. Lettering Size: At least 1-1/2 inches high.

### **PART 3 - EXECUTION**

#### **3.1 PREPARATION**

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

#### **3.2 EQUIPMENT LABEL INSTALLATION**

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

#### **3.3 PIPE LABEL INSTALLATION**

- A. Piping Color-Coding: Painting of piping is specified in Division 09 Section "Interior Painting."
- B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
  - 1. Near each valve and control device.
  - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
  - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
  - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
  - 5. Near major equipment items and other points of origination and termination.
  - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
- C. Pipe Label Color Schedule:
  - 1. Domestic Water Piping:
    - a. Background Color: White.
    - b. Letter Color: Green.
  - 2. Sanitary Waste and Storm Drainage Piping:
    - a. Background Color: White.
    - b. Letter Color: Black.

END OF SECTION 220553

## SECTION 220700 PLUMBING INSULATION

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Insulation Materials:
  - a. Flexible elastomeric.
  - b. Mineral fiber.
2. Insulating cements.
3. Adhesives.
4. Mastics.
5. Sealants.
6. Factory-applied jackets.
7. Tapes.
8. Securements.
9. Corner angles.

#### 1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.

#### 1.3 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
  2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

### PART 2 - PRODUCTS

#### 2.1 INSULATION MATERIALS

- A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Aeroflex USA Inc.; Aerocel.
    - b. Armacell LLC; AP Armaflex.
    - c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.
- G. Mineral-Fiber, Preformed Pipe Insulation:
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Fibrex Insulations Inc.; Coreplus 1200.
    - b. Johns Manville; Micro-Lok.
    - c. Knauf Insulation; 1000 Pipe Insulation.
    - d. Manson Insulation Inc.; Alley-K.
    - e. Owens Corning; Fiberglas Pipe Insulation.
  - 2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

## 2.2 INSULATING CEMENTS

- A. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Insulco, Division of MFS, Inc.; SmoothKote.
    - b. P. K. Insulation Mfg. Co., Inc.; PK No. 127, and Quik-Cote.
    - c. Rock Wool Manufacturing Company; Delta One Shot.

## 2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Flexible Elastomeric: Comply with MIL-A-24179A, Type II, Class I.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Aeroflex USA Inc.; Aero seal.
    - b. Armacell LCC; 520 Adhesive.

- c. RBX Corporation; Rubatex Contact Adhesive.
- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Products, Division of ITW; CP-82.
    - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
    - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
    - d. Marathon Industries, Inc.; 225.
    - e. Mon-Eco Industries, Inc.; 22-25.
- D. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Products, Division of ITW; CP-82.
    - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
    - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
    - d. Marathon Industries, Inc.; 225.

## 2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
- B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Products, Division of ITW; CP-35.
    - b. Foster Products Corporation, H. B. Fuller Company; 30-90.
    - c. ITW TACC, Division of Illinois Tool Works; CB-50.
    - d. Marathon Industries, Inc.; 590.
    - e. Mon-Eco Industries, Inc.; 55-40.
    - f. Vimasco Corporation; 749.
  - 2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
  - 3. Service Temperature Range: Minus 20 to plus 180 deg F.
  - 4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
  - 5. Color: White.
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Products, Division of ITW; CP-10.
    - b. Foster Products Corporation, H. B. Fuller Company; 35-00.
    - c. ITW TACC, Division of Illinois Tool Works; CB-05/15.
    - d. Marathon Industries, Inc.; 550.
    - e. Mon-Eco Industries, Inc.; 55-50.

f. Vimasco Corporation; WC-1/WC-5.

2. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 200 deg F.
4. Solids Content: 63 percent by volume and 73 percent by weight.
5. Color: White.

## 2.5 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.

## 2.6 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:
  - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
  - b. Compac Corp.; 104 and 105.
  - c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
  - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

## 2.7 SECUREMENTS

A. Aluminum Bands: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing or closed seal.

1. Products: Subject to compliance with requirements, provide one of the following:
  - a. Childers Products; Bands.
  - b. PABCO Metals Corporation; Bands.
  - c. RPR Products, Inc.; Bands.

B. Insulation Pins and Hangers:

1. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

- a. Products: Subject to compliance with requirements, provide one of the following:
    - 1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.
    - 2) GEMCO; Perforated Base.
    - 3) Midwest Fasteners, Inc.; Spindle.
  - b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
  - c. Spindle: Aluminum, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
  - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, aluminum sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
    - a. Products: Subject to compliance with requirements, provide one of the following:
      - 1) AGM Industries, Inc.; RC-150.
      - 2) GEMCO; R-150.
      - 3) Midwest Fasteners, Inc.; WA-150.
      - 4) Nelson Stud Welding; Speed Clips.
    - b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
  3. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
    - a. Products: Subject to compliance with requirements, provide one of the following:
      - 1) GEMCO.
      - 2) Midwest Fasteners, Inc.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.
  - D. Wire: 0.062-inch soft-annealed, stainless steel.
    1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - a. C & F Wire.
      - b. Childers Products.
      - c. PABCO Metals Corporation.
      - d. RPR Products, Inc.



## **PART 3 - EXECUTION**

### **3.1 PREPARATION**

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

### **3.2 GENERAL INSTALLATION REQUIREMENTS**

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment and pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
  - 1. Install insulation continuously through hangers and around anchor attachments.
  - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
  - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
  - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
  - a. For below ambient services, apply vapor-barrier mastic over staples.
4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

### 3.3 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.

4. Seal jacket to wall flashing with flashing sealant.
  - D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
  - E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
    1. Comply with requirements in Division 07 Section "Penetration Firestopping" and fire-resistive joint sealers.
  - F. Insulation Installation at Floor Penetrations:
    1. Pipe: Install insulation continuously through floor penetrations.
    2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."
- 3.4 GENERAL PIPE INSULATION INSTALLATION
- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
  - B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
    1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
    2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
    3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
    4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
    5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
    6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
    7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for

above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
  - 1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
  - 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
  - 3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
  - 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
  - 5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

### 3.5 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
  - 1. Install pipe insulation to outer diameter of pipe flange.
  - 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
  - 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
  - 4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
  - 1. Install mitered sections of pipe insulation.
  - 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

### 3.6 MINERAL-FIBER INSULATION INSTALLATION

#### A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

#### B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

#### C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

#### D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

### 3.7 FINISHES

- A. Paint exposed pipe insulation.
- B. Equipment and Pipe Insulation with ASJ or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.
  - 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
    - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- C. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- D. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- E. Do not field paint aluminum or stainless-steel jackets.

### 3.8 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
  - 1. Drainage piping located in crawl spaces.
  - 2. Underground piping.
  - 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

### 3.9 INDOOR PIPING INSULATION SCHEDULE

- A. Domestic Hot and Recirculated Hot Water: Insulation shall be one of the following:
  - 1. Flexible Elastomeric: 1 inch thick.
  - 2. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
- B. Domestic Cold Water: Insulation shall be one of the following:
  - 1. Flexible Elastomeric: 1/2 inch thick.
  - 2. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.
- C. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities: Insulation shall be one of the following:
  - 1. Flexible Elastomeric: 1 inch thick.
  - 2. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

END OF SECTION 220700

## **SECTION 221116**

### **DOMESTIC WATER PIPING**

#### **PART 1 - GENERAL**

##### **1.1 SUMMARY**

- A. Section Includes:
  - 1. Under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
  - 2. Specialty valves.
  - 3. Flexible connectors.

##### **1.2 SUBMITTALS**

- A. Product Data: For each type of product indicated.

##### **1.3 QUALITY ASSURANCE**

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 61 for potable domestic water piping and components.

#### **PART 2 - PRODUCTS**

##### **2.1 PIPING MATERIALS**

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

##### **2.2 COPPER TUBE AND FITTINGS**

- A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.
  - 1. Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.
  - 2. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
  - 3. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
  - 4. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

##### **2.3 PIPING JOINING MATERIALS**

- A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free, unless otherwise indicated; full-face or ring type unless otherwise indicated.

- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

## 2.4 SPECIALTY VALVES

- A. Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for general-duty metal valves.
- B. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves, drain valves, backflow preventers, and vacuum breakers.

## 2.5 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- C. Install shutoff valve immediately upstream of each dielectric fitting.
- D. Install domestic water piping level and plumb.
- E. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- F. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- G. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- H. Install piping adjacent to equipment and specialties to allow service and maintenance.
- I. Install piping to permit valve servicing.
- J. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.
- K. Install piping free of sags and bends.
- L. Install fittings for changes in direction and branch connections.
- M. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.



- N. Install thermometers on outlet piping from each water heater.

## 2.6 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Braze Joints" Chapter.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."
- E. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

## 2.7 VALVE INSTALLATION

- A. General-Duty Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for valve installations.
- B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball or gate valves for piping NPS 4 and smaller.
- C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Division 22 Section "Domestic Water Piping Specialties."
  - 1. Hose-End Drain Valves: At low points in water mains, risers, and branches.
  - 2. Stop-and-Waste Drain Valves: Instead of hose-end drain valves where indicated.

## 2.8 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.
  - 1. Vertical Piping: MSS Type 8 or 42, clamps.
  - 2. Individual, Straight, Horizontal Piping Runs:
    - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
  - 3. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Support vertical piping and tubing at base and at each floor.
- C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

## 2.9 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment and machines to allow service and maintenance

## 2.10 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Piping Inspections:
  - 1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
  - 2. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
    - a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
    - b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
  - 3. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
  - 4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- C. Piping Tests:
  - 1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
  - 2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
  - 3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
  - 4. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
  - 5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
  - 6. Prepare reports for tests and for corrective action required.
- D. Domestic water piping will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

## 2.11 CLEANING

- A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
  2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
    - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    - b. Fill and isolate system according to either of the following:
      - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
      - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
    - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
    - d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- B. Prepare and submit reports of purging and disinfecting activities.
- C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

## 2.12 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Aboveground domestic water piping, shall be one of the following:
1. Hard copper tube, ASTM B 88, Type L, cast or wrought copper solder-joint fittings; and soldered joints.
  2. Hard copper tube, ASTM B 88, Type L, copper pressure-seal-joint fittings; and pressure-sealed joints.

## 2.13 VALVE SCHEDULE

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
1. Shutoff Duty: Use ball valves for piping NPS 4 and smaller.
  2. Throttling Duty: Use ball valves for piping NPS 4 and smaller.
- B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

END OF SECTION 221116

## **SECTION 221119 DOMESTIC WATER PIPING SPECIALTIES**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. This Section includes the following domestic water piping specialties:

1. Vacuum breakers.
2. Temperature-actuated water mixing valves.
3. Strainers.
4. Hose bibbs.
5. Wall hydrants.
6. Drain valves.
7. Water hammer arresters.

#### **1.2 SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Field quality-control test reports.
- C. Operation and maintenance data.

#### **1.3 PERFORMANCE REQUIREMENTS**

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

#### **1.4 QUALITY ASSURANCE**

- A. NSF Compliance:
1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.
  2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

### **PART 2 - PRODUCTS**

#### **2.1 VACUUM BREAKERS**

- A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Ames Co.
  - b. Cash Acme.
  - c. Conbraco Industries, Inc.
  - d. FEBCO; SPX Valves & Controls.
  - e. Rain Bird Corporation.
  - f. Toro Company (The); Irrigation Div.
  - g. Watts Industries, Inc.; Water Products Div.
  - h. Zurn Plumbing Products Group; Wilkins Div.
3. Standard: ASSE 1001.
4. Size: NPS 1/4 to NPS 3, as required to match connected piping.
5. Body: Bronze.
6. Inlet and Outlet Connections: Threaded.
7. Finish: Rough bronze or chrome plated.

B. Hose-Connection Vacuum Breakers:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Arrowhead Brass Products, Inc.
  - b. Cash Acme.
  - c. Conbraco Industries, Inc.
  - d. Legend Valve.
  - e. MIFAB, Inc.
  - f. Prier Products, Inc.
  - g. Watts Industries, Inc.; Water Products Div.
  - h. Woodford Manufacturing Company.
  - i. Zurn Plumbing Products Group; Light Commercial Operation.
  - j. Zurn Plumbing Products Group; Wilkins Div.
3. Standard: ASSE 1001.
4. Body: Bronze, nonremovable, with manual drain.
5. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
6. Finish: Rough bronze or chrome plated.

2.2 TEMPERATURE-ACTUATED WATER MIXING VALVES

A. Thermostatic, Water Mixing Valves:

1. Basis-of-Design Product: Provide the product listed in the plumbing fixture schedule or equivalent product by one of the following:
  - a. Armstrong International, Inc.
  - b. Lawler Manufacturing Company, Inc.

- c. Leonard Valve Company.
- d. Powers; a Watts Industries Co.
- e. Symmons Industries, Inc.

## 2.3 STRAINERS FOR DOMESTIC WATER PIPING

### A. Y-Pattern Strainers:

- 1. Pressure Rating: 125 psig minimum, unless otherwise indicated.
- 2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for NPS 2-1/2 and larger.
- 3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
- 4. Screen: Stainless steel with round perforations, unless otherwise indicated.
- 5. Perforation Size:
  - a. Strainers NPS 2 and Smaller: 0.033 inch.
  - b. Strainers NPS 2-1/2 to NPS 4: 0.062 inch.
  - c. Strainers NPS 5 and Larger: 0.125 inch.
- 6. Drain: Factory-installed, hose-end drain valve.

## 2.4 HOSE BIBBS

### A. Hose Bibbs: Basis-of-Design Product: Provide the product listed in the plumbing fixture schedule or equivalent product by one of the following:

- 1. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
- 2. Watts Drainage Products Inc.
- 3. Woodford Manufacturing Company.
- 4. Zurn Plumbing Products Group; Light Commercial Operation.

## 2.5 WALL HYDRANTS

### A. Nonfreeze Wall Hydrants: Basis-of-Design Product: Provide the product listed in the plumbing fixture schedule or equivalent product by one of the following:

- 1. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
- 2. Tyler Pipe; Wade Div.
- 3. Watts Drainage Products Inc.
- 4. Woodford Manufacturing Company.
- 5. Zurn Plumbing Products Group; Light Commercial Operation.

## 2.6 DRAIN VALVES

### A. Ball-Valve-Type, Hose-End Drain Valves:

- 1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
- 2. Pressure Rating: 400-psig minimum CWP.
- 3. Size: NPS 3/4.
- 4. Body: Copper alloy.

5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

## 2.7 WATER HAMMER ARRESTERS

### A. Water Hammer Arresters:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. AMTROL, Inc.
  - b. Josam Company.
  - c. MIFAB, Inc.
  - d. PPP Inc.
  - e. Sioux Chief Manufacturing Company, Inc.
  - f. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
  - g. Tyler Pipe; Wade Div.
  - h. Watts Drainage Products Inc.
  - i. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Metal bellows or Copper tube with piston.
4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
- B. Install Y-pattern strainers for water on supply side of each control valve, water pressure-reducing valve, solenoid valve, and pump.
- C. Install water hammer arresters in water piping according to PDI-WH 201.
- D. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.
- E. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties.
- F. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
  1. Primary, thermostatic, water mixing valves.

- G. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

### 3.2 FIELD QUALITY CONTROL

- A. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

### 3.3 ADJUSTING

- A. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

END OF SECTION 221119



**SECTION 221123**  
**FACILITY NATURAL GAS PIPING**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
1. Pipes, tubes, and fittings.
  2. Piping specialties.
  3. Piping and tubing joining materials.
  4. Valves.
  5. Pressure regulators.

**1.2 SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
- C. Delegated-Design Submittal: For natural-gas piping and equipment indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
1. Detail fabrication and assembly of seismic restraints.
  2. Design Calculations: Calculate requirements for selecting seismic restraints.
- D. Welding certificates.
- E. Field quality-control reports.
- F. Operation and maintenance data.

**1.3 PERFORMANCE REQUIREMENTS**

- A. Minimum Operating-Pressure Ratings:
1. Piping and Valves: 100 psig minimum unless otherwise indicated.
  2. Service Regulators: 100 psig Insert value minimum unless otherwise indicated.
- B. Natural-Gas System Pressure within Buildings: 0.5 psig or less.
- C. Natural-Gas System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 0.5 psig but not more than 2 psig, and is reduced to secondary pressure of 0.5 psig or less.

- D. Delegated Design: Design restraints and anchors for natural-gas piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

#### 1.4 QUALITY ASSURANCE

- A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

### PART 2 - PRODUCTS

#### 2.1 PIPES, TUBES, AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
  - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
  - 2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
  - 3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
  - 4. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
    - a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.
- B. PE Pipe: ASTM D 2513, SDR 11.
  - 1. PE Fittings: ASTM D 2683, socket-fusion type or ASTM D 3261, butt-fusion type with dimensions matching PE pipe.
  - 2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D 2513, SDR 11; and steel pipe complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
  - 3. Anodeless Service-Line Risers: Factory fabricated and leak tested.
    - a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet.
    - b. Casing: Steel pipe complying with ASTM A 53/A 53M, Schedule 40, black steel, Type E or S, Grade B, with corrosion-protective coating covering. Vent casing aboveground.
    - c. Aboveground Portion: PE transition fitting.
    - d. Outlet shall be threaded or suitable for welded connection.
    - e. Tracer wire connection.
    - f. Ultraviolet shield.
    - g. Stake supports with factory finish to match steel pipe casing or carrier pipe.
  - 4. Transition Service-Line Risers: Factory fabricated and leak tested.

- a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet connected to steel pipe complying with ASTM A 53/A 53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.
- b. Outlet shall be threaded or suitable for welded connection.
- c. Bridging sleeve over mechanical coupling.
- d. Factory-connected anode.
- e. Tracer wire connection.
- f. Ultraviolet shield.
- g. Stake supports with factory finish to match steel pipe casing or carrier pipe.

## 2.2 PIPING SPECIALTIES

### A. Appliance Flexible Connectors:

1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
4. Corrugated stainless-steel tubing with polymer coating.
5. Operating-Pressure Rating: 0.5 psig.
6. End Fittings: Zinc-coated steel.
7. Threaded Ends: Comply with ASME B1.20.1.
8. Maximum Length: 72 inches

### B. Quick-Disconnect Devices: Comply with ANSI Z21.41.

1. Copper-alloy convenience outlet and matching plug connector.
2. Nitrile seals.
3. Hand operated with automatic shutoff when disconnected.
4. For indoor or outdoor applications.
5. Adjustable, retractable restraining cable.

### C. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

### D. Deck Mounted Lab Turrets:

1. Dual ball valves with turret and check and two inlets with valves mounted at 90°.
2. Chrome plated with serrated, full-flow laboratory nozzle.

### E. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

## 2.3 JOINING MATERIALS

### A. Joint Compound and Tape: Suitable for natural gas.

- B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

## 2.4 MANUAL GAS SHUTOFF VALVES

- A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.
- B. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.
  - 1. CWP Rating: 125 psig.
  - 2. Threaded Ends: Comply with ASME B1.20.1.
  - 3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
  - 4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
  - 5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
  - 6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.
- C. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. BrassCraft Manufacturing Company; a Masco company.
    - b. Conbraco Industries, Inc.; Apollo Div.
    - c. Lyall, R. W. & Company, Inc.
    - d. McDonald, A. Y. Mfg. Co.
    - e. Perfection Corporation; a subsidiary of American Meter Company.
  - 2. Body: Bronze, complying with ASTM B 584.
  - 3. Ball: Chrome-plated bronze.
  - 4. Stem: Bronze; blowout proof.
  - 5. Seats: Reinforced TFE; blowout proof.
  - 6. Packing: Threaded-body packnut design with adjustable-stem packing.
  - 7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
  - 8. CWP Rating: 600 psig.
  - 9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
  - 10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- D. Bronze Plug Valves: MSS SP-78.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Lee Brass Company.
    - b. McDonald, A. Y. Mfg. Co.

2. Body: Bronze, complying with ASTM B 584.
3. Plug: Bronze.
4. Ends: Threaded, socket, as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5. Operator: Square head or lug type with tamperproof feature where indicated.
6. Pressure Class: 125 psig.
7. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

E. Valve Boxes:

1. Cast-iron, two-section box.
2. Top section with cover with "GAS" lettering.
3. Bottom section with base to fit over valve and barrel a minimum of 5 inches in diameter.
4. Adjustable cast-iron extensions of length required for depth of bury.
5. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head, and with stem of length required to operate valve.

## 2.5 MOTORIZED GAS VALVES

A. Electrically Operated Valves: Comply with UL 429.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - a. ASCO Power Technologies, LP; Division of Emerson.
  - b. Dungs, Karl, Inc.
  - c. Eclipse Combustion, Inc.
  - d. Goyen Valve Corp.; Tyco Environmental Systems.
  - e. Magnatrol Valve Corporation.
  - f. Parker Hannifin Corporation; Climate & Industrial Controls Group; Skinner Valve Div.
  - g. Watts Regulator Co.; Division of Watts Water Technologies, Inc.
3. Pilot operated.
4. Body: Brass or aluminum.
5. Seats and Disc: Nitrile rubber.
6. Springs and Valve Trim: Stainless steel.
7. 120-V ac, 60 Hz, Class B, continuous-duty molded coil, and replaceable.
8. NEMA ICS 6, Type 4, coil enclosure.
9. Normally closed.
10. Visual position indicator.

## 2.6 EARTHQUAKE VALVES

A. Earthquake Valves: Comply with ASCE 25.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - a. Vanguard Valves, Inc.
3. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
4. Maximum Operating Pressure: 5 psig.
5. Cast-aluminum body with nickel-plated chrome steel internal parts.
6. Nitrile-rubber valve washer.
7. Sight windows for visual indication of valve position.
8. Threaded end connections complying with ASME B1.20.1.
9. Wall mounting bracket with bubble level indicator.

## 2.7 PRESSURE REGULATORS

### A. General Requirements:

1. Single stage and suitable for natural gas.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 and smaller.

### B. Line Pressure Regulators: Comply with ANSI Z21.80.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - a. Actaris.
  - b. American Meter Company.
  - c. Eclipse Combustion, Inc.
  - d. Fisher Control Valves and Regulators; Division of Emerson Process Management.
  - e. Invensys.
  - f. Maxitrol Company.
  - g. Richards Industries; Jordan Valve Div.
3. Body and Diaphragm Case: Cast iron or die-cast aluminum.
4. Springs: Zinc-plated steel; interchangeable.
5. Diaphragm Plate: Zinc-plated steel.
6. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
7. Orifice: Aluminum; interchangeable.
8. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
9. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
10. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
11. Overpressure Protection Device: Factory mounted on pressure regulator.
12. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
13. Maximum Inlet Pressure: 5 psig.

### C. Appliance Pressure Regulators: Comply with ANSI Z21.18.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - a. Canadian Meter Company Inc.
  - b. Eaton Corporation; Controls Div.
  - c. Harper Wyman Co.
  - d. Maxitrol Company.
  - e. SCP, Inc.
3. Body and Diaphragm Case: Die-cast aluminum.
4. Springs: Zinc-plated steel; interchangeable.
5. Diaphragm Plate: Zinc-plated steel.
6. Seat Disc: Nitrile rubber.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
9. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
10. Maximum Inlet Pressure: 2 psig.

## 2.8 DIELECTRIC UNIONS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Capitol Manufacturing Company.
  2. Central Plastics Company.
  3. Hart Industries International, Inc.
  4. McDonald, A. Y. Mfg. Co.
  5. Watts Regulator Co.; Division of Watts Water Technologies, Inc.
  6. Wilkins; Zurn Plumbing Products Group.
- B. Minimum Operating-Pressure Rating: Insert pressure.
- C. Combination fitting of copper alloy and ferrous materials.
- D. Insulating materials suitable for natural gas.
- E. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

## 2.9 SLEEVES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

## 2.10 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Advance Products & Systems, Inc.
    - b. Calpico Inc.
    - c. Metraflex Company (The).
    - d. Pipeline Seal and Insulator, Inc.
  - 2. Sealing Elements: NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe and sleeve.
  - 3. Pressure Plates: Carbon steel.
  - 4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one nut and bolt for each sealing element.

## 2.11 LABELING AND IDENTIFYING

- A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

## PART 3 - EXECUTION

### 3.1 OUTDOOR PIPING INSTALLATION

- A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.
- B. Install underground, natural-gas piping buried at least 36 inches below finished grade. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.
  - 1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.
- C. Install underground, PE, natural-gas piping according to ASTM D 2774.
- D. Steel Piping with Protective Coating:
  - 1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
  - 2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
  - 3. Replace pipe having damaged PE coating with new pipe.
- E. Copper Tubing with Protective Coating:



1. Apply joint cover kits over tubing to cover, seal, and protect joints.
2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.

- F. Install fittings for changes in direction and branch connections.
- G. Exterior-Wall Pipe Penetrations: Seal penetrations using steel or cast-iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- H. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- I. Install pressure gage downstream from each service regulator. Pressure gages are specified in Division 23 Section "Meters and Gages for HVAC Piping."

### 3.2 INDOOR PIPING INSTALLATION

- A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
- D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- G. Locate valves for easy access.
- H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and branch connections.
- K. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."
- L. Verify final equipment locations for roughing-in.

- M. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
  - N. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
    - 1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
  - O. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
  - P. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
  - Q. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
  - R. Connect branch piping from top or side of horizontal piping.
  - S. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment.
  - T. Do not use natural-gas piping as grounding electrode.
  - U. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
  - V. Install pressure gage downstream from each line regulator. Pressure gages are specified in Division 23 Section "Meters and Gages for HVAC Piping."
- 3.3 VALVE INSTALLATION
- A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing or copper connector.
  - B. Install underground valves with valve boxes.
  - C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.
  - D. Install earthquake valves aboveground outside buildings according to listing.
  - E. Install anode for metallic valves in underground PE piping.
- 3.4 PIPING JOINT CONSTRUCTION
- A. Ream ends of pipes and tubes and remove burrs.

- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints:
  - 1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
  - 2. Cut threads full and clean using sharp dies.
  - 3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
  - 4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
  - 5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- D. Welded Joints:
  - 1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
  - 2. Bevel plain ends of steel pipe.
  - 3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.
- E. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
  - 1. Plain-End Pipe and Fittings: Use butt fusion.
  - 2. Plain-End Pipe and Socket Fittings: Use socket fusion.

### 3.5 HANGER AND SUPPORT INSTALLATION

- A. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
  - 1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
  - 2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
  - 3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
- B. Install hangers for horizontal, corrugated stainless-steel tubing with the following maximum spacing and minimum rod sizes:
  - 1. NPS 3/8: Maximum span, 48 inches; minimum rod size, 3/8 inch.
  - 2. NPS 1/2: Maximum span, 72 inches; minimum rod size, 3/8 inch.
  - 3. NPS 3/4 and Larger: Maximum span, 96 inches; minimum rod size, 3/8 inch.

### 3.6 CONNECTIONS

- A. Connect to utility's gas main according to utility's procedures and requirements.
- B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
- C. Install piping adjacent to appliances to allow service and maintenance of appliances.

- D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.
- E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

### 3.7 LABELING AND IDENTIFYING

- A. Comply with requirements in Division 23 Section "Identification for HVAC Piping and Equipment" for piping and valve identification. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

### 3.8 FIELD QUALITY CONTROL

- A. Test, inspect, and purge natural gas according to the International Fuel Gas Code and authorities having jurisdiction.
- B. Natural-gas piping will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

### 3.9 OUTDOOR PIPING SCHEDULE

- A. Underground natural-gas piping shall be one of the following:
  - 1. PE pipe and fittings joined by heat fusion; service-line risers with tracer wire terminated in an accessible location.
  - 2. Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
- B. Aboveground natural-gas piping shall be one of the following:
  - 1. Steel pipe with malleable-iron fittings and threaded joints.
  - 2. Steel pipe with wrought-steel fittings and welded joints.
- C. Branch Piping in Cast-in-Place Concrete to Single Appliance: Annealed-temper copper tube with wrought-copper fittings and brazed joints. Install piping embedded in concrete with no joints in concrete.
- D. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

### 3.10 INDOOR PIPING SCHEDULE

- A. Aboveground, branch piping NPS 1/2 and smaller shall be the following:
  - 1. Steel pipe with malleable-iron fittings and threaded joints.

- B. Aboveground, distribution piping shall be one of the following:
  - 1. Steel pipe with malleable-iron fittings and threaded joints.
  - 2. Steel pipe with wrought-steel fittings and welded joints.
- C. Underground, below building, piping shall be one of the following:
  - 1. Steel pipe with malleable-iron fittings and threaded joints.
  - 2. Steel pipe with wrought-steel fittings and welded joints.
- D. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
- E. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

### 3.11 UNDERGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Connections to Existing Gas Piping: Use valve and fitting assemblies made for tapping utility's gas mains and listed by an NRTL.
- B. Underground: PE valves.

### 3.12 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Valves for pipe sizes NPS 2 and smaller at service meter shall be the following:
  - 1. Two-piece, full-port, bronze ball valves with bronze trim.
- B. Distribution piping valves for pipe sizes NPS 2 and smaller shall be the following:
  - 1. Two-piece, full-port, bronze ball valves with bronze trim.
- C. Valves in branch piping for single appliance shall be the following:
  - 1. Two-piece, full-port, bronze ball valves with bronze trim.

END OF SECTION 231123

## **SECTION 221316**

### **SANITARY WASTE AND VENT PIPING**

#### **PART 1 - GENERAL**

##### **1.1 SUMMARY**

- A. This Section includes the following soil and waste, sanitary drainage and vent piping inside the building:
  - 1. Pipe, tube, and fittings.
  - 2. Special pipe fittings.

##### **1.2 SUBMITTALS**

- A. Field quality-control inspection and test reports.

##### **1.3 PERFORMANCE REQUIREMENTS**

- A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:
  - 1. Soil, Waste, and Vent Piping: 10-foot head of water.

##### **1.4 QUALITY ASSURANCE**

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping; and "NSF-drain" for plastic drain piping.

#### **PART 2 - PRODUCTS**

##### **2.1 PIPING MATERIALS**

- A. Hub-and-Spigot, Cast-Iron Pipe and Fittings: ASTM A 74, Service class.
  - 1. Gaskets: ASTM C 564, rubber.
- B. Solid-Wall PVC Pipe: ASTM D 2665, solid-wall drain, waste, and vent.
  - 1. PVC Socket Fittings: ASTM D 2665, socket type, made to ASTM D 3311, drain, waste, and vent patterns.

## **PART 3 - EXECUTION**

### **3.1 PIPING APPLICATIONS**

- A. Special pipe fittings with pressure ratings at least equal to piping pressure ratings may be used in applications below, unless otherwise indicated.
- B. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.
- C. Aboveground, soil, waste, and vent piping NPS 4 and smaller shall be any of the following:
  - 1. Service class, hub-and-spigot, cast-iron soil pipe and fittings; gaskets; and compression joints.
  - 2. Solid-wall Cellular-core PVC pipe, PVC socket fittings, and solvent-cemented joints.
- D. Aboveground, soil, waste, and vent piping NPS 5 and larger shall be any of the following:
  - 1. Service class, cast-iron soil pipe and fittings; gaskets; and compression joints.
  - 2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
- E. Underground, soil, waste, and vent piping NPS 4 and smaller shall be any of the following:
  - 1. Service class, hub-and-spigot, cast-iron soil pipe and fittings; gaskets; and compression joints.
  - 2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
- F. Underground, soil and waste Piping NPS 5 and larger shall be any of the following:
  - 1. Service class, cast-iron soil pipe and fittings; gaskets; and compression joints.
  - 2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

### **3.2 PIPING INSTALLATION**

- A. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- B. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.
- C. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 22 Section "Common Work Results for Plumbing."
- D. Install wall penetration system at each service pipe penetration through foundation wall. Make installation watertight. Wall penetration systems are specified in Division 22 Section "Common Work Results for Plumbing."
- E. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
- F. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be

used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

- G. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- H. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise required by code or indicated:
  - 1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
  - 2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
  - 3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- I. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.
- J. Install PVC soil and waste drainage and vent piping according to ASTM D 2665.
- K. Install underground PVC soil and waste drainage piping according to ASTM D 2321.
- L. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

### 3.3 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- B. Cast-Iron, Soil-Piping Joints: Make joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
  - 1. Gasketed Joints: Make with rubber gasket matching class of pipe and fittings.
- C. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

### 3.4 VALVE INSTALLATION

- A. General-duty valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

### 3.5 HANGER AND SUPPORT INSTALLATION

- A. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:



1. Vertical Piping: MSS Type 8 or Type 42, clamps.
  2. Individual, Straight, Horizontal Piping Runs: According to the following:
    - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
    - c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
  3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
  4. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
  2. NPS 3: 60 inches with 1/2-inch rod.
  3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
  4. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
- F. Install supports for vertical cast-iron soil piping every 15 feet.
- G. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
  2. NPS 3: 48 inches with 1/2-inch rod.
  3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
- H. Install supports for vertical PVC piping every 48 inches.
- I. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.
- 3.6 CONNECTIONS
- A. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- B. Connect drainage and vent piping to the following:
1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
  2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
  3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.

4. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

### 3.7 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
  1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
  2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction.
  1. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
  2. Prepare reports for tests and required corrective action.

### 3.8 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

### 3.9 PROTECTION

- A. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

END OF SECTION 221316

## **SECTION 221319 SANITARY WASTE PIPING SPECIALTIES**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. This Section includes the following sanitary drainage piping specialties:

1. Cleanouts.
2. Floor drains.
3. Roof flashing assemblies.
4. Miscellaneous sanitary drainage piping specialties.

#### **1.2 SUBMITTALS**

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for grease interceptors.

#### **1.3 QUALITY ASSURANCE**

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

### **PART 2 - PRODUCTS**

#### **2.1 CLEANOUTS**

- A. Exposed Cast-Iron Cleanouts:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Josam Company; Josam Div.
  - b. MIFAB, Inc.
  - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
  - d. Watts Drainage Products Inc.
  - e. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M for cast iron cleanout test tee.
3. Size: Same as connected drainage piping
4. Body Material: As required to match connected piping.
5. Closure: Raised heat plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

- B. Cast-Iron Floor Cleanouts:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Josam Company; Josam Div.
  - b. Oatey.
  - c. Sioux Chief Manufacturing Company, Inc.
  - d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
  - e. Watts Drainage Products Inc.
  - f. Zurn Plumbing Products Group; Light Commercial Operation.
  - g. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M for heavy-duty, adjustable housing cleanout.
3. Size: Same as connected branch.
4. Body or Ferrule: Cast Iron.
5. Clamping Device: **Required**.
6. Outlet Connection: Inside caulk.
7. Closure: Brass plug with straight threads and gasket.
8. Adjustable Housing Material: Cast iron.
9. Frame and Cover Material and Finish: Polished bronze.
10. Frame and Cover Shape: Round
11. Top Loading Classification: Heavy Duty.
12. Riser: ASTM A 74, service class, cast-iron drainage pipe fitting and riser to cleanout.

C. Wall Cleanouts:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Josam Company; Josam Div.
  - b. MIFAB, Inc.
  - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
  - d. Watts Drainage Products Inc.
  - e. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: as required to match connected piping.
5. Closure: Countersunk or raised head plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, flat chrome plated bronze cover plate with screw.
8. Wall Access: Round wall-installation frame and cover.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on the drawings or a comparable product by one of the following:
  - a. Commercial Enameling Co.
  - b. Josam Company; Josam Div.
  - c. MIFAB, Inc.

- d. Prier Products, Inc.
  - e. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
  - f. Watts Drainage Products Inc.
  - g. Zurn Plumbing Products Group; Light Commercial Operation.
  - h. Zurn Plumbing Products Group; Specification Drainage Operation.
- 2. Standard: ASME A112.6.3.
  - 3. Pattern: Floor drain.
  - 4. Body Material: Gray Iron.
  - 5. Outlet: Bottom.
  - 6. Top or Strainer Material: Bronze.
  - 7. Top of Body and Strainer Finish: Nickel bronze.
  - 8. Top Shape: Round.
  - 9. Trap Pattern: Deep-seal p-trap.

## 2.3 ROOF VENT FLASHING ASSEMBLIES

### A. Roof Vent Flashing Assemblies:

- 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Thaler Metal Industries Ltd.

### B. Description: Manufactured assembly made of 0.064-inch-thick, aluminum manufactured to CSA B272-93 with EPDM triple pressure grommet seal and EPDM Base Seal.

- 1. Warranty: 20-year against leaks, condensation, and defects in materials and/or manufacture.

## 2.4 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

### A. Air-Gap Fittings:

- 1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
- 2. Body: Bronze or cast iron.
- 3. Inlet: Opening in top of body.
- 4. Outlet: Larger than inlet.
- 5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

### B. Sleeve Flashing Device:

- 1. Description: Manufactured, cast-iron fitting, with clamping device that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 2 inches above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
- 2. Size: As required for close fit to riser or stack piping.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
- B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
  - 1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
  - 2. Locate at each change in direction of piping greater than 45 degrees.
  - 3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
  - 4. Locate at base of each vertical soil and waste stack.
- C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- E. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
  - 1. Position floor drains for easy access and maintenance.
  - 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
    - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
    - b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
    - c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
  - 3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
  - 4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- F. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.
- G. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.
- H. Assemble open drain fittings and install with top of hub 2 inches.
- I. Install deep-seal traps on floor drains and other waste outlets.
- J. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- K. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

### 3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.

### 3.3 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each grease interceptor.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

### 3.4 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221319

## **SECTION 223100 DOMESTIC WATER SOFTENERS**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. This Section includes commercial water softeners.
  - 1. Chemicals.
  - 2. Water testing kits.

#### **1.2 SUBMITTALS**

- A. Product Data: Include rated capacities, operating characteristics, dimensions, piping system connection, furnished specialties, and accessories.
- B. Operation and Maintenance Data.

#### **1.3 QUALITY ASSURANCE**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

#### **1.4 EXTRA MATERIALS**

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Salt for Brine Tanks: Furnish crystallized solar salt and at least two times original load. Deliver on pallets in 40- or 50-lb packages.
  - 2. Store salt on raised platform where directed by Owner. Do not store in contact with concrete floor.

### **PART 2 - PRODUCTS**

#### **2.1 COMMERCIAL WATER SOFTENERS**

- A. Description: Factory-assembled, pressure-type water softener.
  - 1. Manufacturers:
    - a. Alamo Water Treatment; Ecodyne Water Treatment.
    - b. Columbia Water Conditioning Systems, Inc.
    - c. CSI Water Treatment Systems; a division of Chandler Systems, Inc.
    - d. Culligan International Company.
    - e. CUNO Incorporated.
    - f. Diamond Water Conditioning.



- g. Diamond Water Systems, Inc.
  - h. Environmental Dynamics Corporation.
  - i. Hungerford & Terry, Inc.
  - j. Ion Exchange Products, Inc.
  - k. Kinetico Incorporated.
  - l. Marlo, Inc.
  - m. Parker Boiler Co.
  - n. Plymouth Products, Inc.
  - o. Rainsoft Div.; Aquion Partners L.P.
  - p. Springsoft Intl., Inc.
  - q. Water & Power Technologies, Inc.
  - r. Water King, Inc.
  - s. Water Soft, Inc.
2. Comply with NSF 61, "Drinking Water System Components--Health Effects."
3. Configuration: Single unit with one mineral tank and one brine tank.
4. Mineral Tanks: Stainless steel, electric welded; pressure-vessel quality.
- a. Construction: Fabricated and stamped to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels."
  - b. Pressure Rating: 125 psig minimum.
  - c. Wetted Components: Suitable for water temperatures from 40 to at least 120 deg F.
  - d. Freeboard: 50 percent minimum for backwash expansion above normal resin bed level.
  - e. Handholes: 4 inches round or 4 by 6 inches elliptical, in top head and lower sidewall of tanks 30 inches and smaller in diameter.
  - f. Manhole: 11 by 15 inches in top head of tanks larger than 30 inches in diameter.
  - g. Support Legs or Skirt: Constructed of structural steel, welded to tank.
  - h. Finish: Hot-dip galvanized on exterior and interior of tank after fabrication, unless tank is stainless steel.
  - i. Finish: Exterior of tank spray painted with rust-resistant prime coat, 2- to 3-mil dry film thickness. Interior sandblasted and lined with epoxy-polyamide coating, 8- to 10-mil dry film thickness.
  - j. Upper Distribution System: Single, point type, fabricated from galvanized-steel pipe and fittings.
  - k. Lower Distribution System: Hub and radial-arm or header-lateral type; fabricated from PVC pipe and fittings with individual, fine-slotted, nonclogging PE strainers; arranged for even flow distribution through resin bed.
  - l. Liner: PE, ABS, or other material suitable for potable water.
5. Controls: Fully automatic; factory mounted on unit and factory wired.
- a. Adjustable duration of various regeneration steps.
  - b. Push-button start and complete manual operation.
  - c. Electric time clock and switch for fully automatic operation, adjustable to initiate regeneration at any hour of day and any day of week or at fixed intervals.
  - d. Sequence of Operation: Program multiport pilot-control valve to automatically pressure-actuate main operating valve through steps of regeneration and return to service.
  - e. Pointer on pilot-control valve shall indicate cycle of operation.
  - f. Means of manual operation of pilot-control valve if power fails.
  - g. Main Operating Valves: Industrial, automatic, multiport, diaphragm type with the following features:

- 1) Slow opening and closing, nonslam operation.
  - 2) Diaphragm guiding on full perimeter from fully open to fully closed.
  - 3) Isolated dissimilar metals within valve.
  - 4) Self-adjusting, internal, automatic brine injector that draws brine and rinses at constant rate independent of pressure.
  - 5) Valve for single mineral-tank unit with internal automatic bypass of raw water during regeneration.
  - 6) Sampling cocks for soft water.
  - 7) Special tools are not required for service.
- h. Flow Control: Automatic, to control backwash and flush rates over wide variations in operating pressures, and that does not require field adjustments.
  - 1) Demand-Initiated Control: Equip single mineral-tank units with automatic-reset-head water meter that electrically activates cycle controller to initiate regeneration at preset total in gallons. Design so head automatically resets to preset total in gallons for next service run.
  - 2) Demand-Initiated Control: Equip each mineral tank of twin mineral-tank units with automatic-reset-head water meter in common outlet header that electrically activates cycle controller to automatically regenerate one mineral tank at preset total in gallons and divert flow to other tank. Set to repeat with other tank. Include electrical lockout to prevent simultaneous regeneration of both tanks.
6. Brine Tank: Combination measuring and wet-salt storing system.
  - a. Tank and Cover Material: Fiberglass, 3/16 inch thick; or molded PE, 3/8 inch thick.
  - b. Brine Valve: Float operated and plastic fitted for automatic control of brine withdrawn and freshwater refill.
  - c. Size: Large enough for at least four regenerations at full salting.
7. Factory-Installed Accessories:
  - a. Piping, valves, tubing, and drains.
  - b. Sampling cocks.
  - c. Main-operating-valve position indicators.
  - d. Water meters.
- B. Capacity and Characteristics:
  1. Service: Hot water.
  2. Water Analysis:
    - a. Hardness: 5-12 grains/gal.
    - b. Dissolved Solids: < 2,000 ppm.
    - c. Concentration: 6.5-9.5 pH.
    - d. Chloride: < 150 ppm.
  3. Continuous Service Flow Rate: 9 gpm at 15-psig pressure drop.
  4. Mineral Quantity, Each Tank: 1 cu. ft.
  5. Mineral Exchange Capacity: 31,000 grains/cu. ft. @ 12 lb of salt.
  6. Electrical Characteristics:
    - a. Volts: 120.

7. Salt Capacity: 25 lb.

## 2.2 CHEMICALS

- A. Salt for Brine Tanks: High-purity sodium chloride; free of dirt and foreign material. Rock and granulated forms are not acceptable.
  1. Form: Processed, crystallized solar salt from shallow ponds and milled into irregular particles.

## 2.3 WATER TESTING SETS

- A. Description: Manufacturer's standard water-hardness testing apparatus and chemicals with testing procedure instructions. Include metal container suitable for wall mounting.

# PART 3 - EXECUTION

## 3.1 WATER SOFTENER INSTALLATION

- A. Install commercial water softener equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor mineral and brine tanks and floor-mounting accessories to substrate.
- B. Install brine lines and fittings furnished by equipment manufacturer but not specified to be factory installed.
- C. Prepare mineral-tank distribution system and underbed for minerals and place specified mineral into mineral tanks.
- D. Install water testing sets mounted on wall, unless otherwise indicated, and near water softeners.

## 3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Make piping connections between water-softener-unit headers and dissimilar-metal water piping with dielectric fittings.
- D. Install shutoff valves on raw-water inlet and soft-water outlet piping of each mineral tank.
- E. Install pressure gages on raw-water inlet and soft-water outlet piping of each mineral tank.
- F. Install valved bypass water piping around water softeners.
- G. Install drains as indirect wastes to spill into open drains or over floor drains.

### 3.3 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
  - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
  - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Remove and replace malfunctioning water softeners that do not pass tests and inspections and retest as specified above.

### 3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial water softeners.

END OF SECTION 223100

## **SECTION 223400**

### **FUEL FIRED DOMESTIC WATER HEATERS**

#### **PART 1 - GENERAL**

##### **1.1 SUMMARY**

- A. This Section includes the following fuel-fired water heaters:
  - 1. Commercial, power-burner, storage, gas water heaters.
  - 2. Water heater accessories.

##### **1.2 SUBMITTALS**

- A. Product Data: For each type and size of water heater indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Operation and maintenance data.
- D. Warranty.

##### **1.3 QUALITY ASSURANCE**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- C. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9" for all components that will be in contact with potable water.

##### **1.4 WARRANTY**

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-fired water heaters that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Structural failures including storage tank and supports.
    - b. Faulty operation of controls.
    - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
  - 2. Warranty Period(s): From date of Substantial Completion:

- a. Commercial, Gas Water Heaters: Three years.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

### 2.2 COMMERCIAL, GAS WATER HEATERS

- A. Commercial, Condensing Style, Power-Burner, Storage, Gas Water Heaters: Comply with ANSI Z21.10.3/CSA 4.3.
  1. Manufacturers:
    - a. Bradford White Corporation.
    - b. Precision Boilers.
    - c. PVI Industries, LLC.
    - d. RECO USA.
    - e. Sellers Engineering Co.
    - f. Smith, A. O. Water Products Company.
  2. Storage-Tank Construction: ASME-code steel with 150-psig working-pressure rating.
    - a. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.
      - 1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
    - b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
  3. Factory-Installed, Storage-Tank Appurtenances:
    - a. Anode Rod: Replaceable magnesium.
    - b. Dip Tube: Provide unless cold-water inlet is near bottom of tank.
    - c. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
    - d. Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.
    - e. Jacket: Steel with enameled finish.
    - f. Combination Temperature and Pressure Relief Valves: ANSI Z21.22/CSA 4.4. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.
  4. Burner: Comply with UL 795 for power-burner water heaters and for natural gas fuel.

- a. Automatic Ignition: ANSI Z21.20, electric, automatic, gas-ignition system.
  - 5. Temperature Control: Adjustable thermostat.
  - 6. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.
  - 7. Special Requirements: NSF 5 construction.
  - 8. Draft Hood: Draft diverter; complying with ANSI Z21.12.
  - 9. Energy Management System Interface: Normally closed dry contacts for enabling and disabling water heater.
- B. Capacity and Characteristics:
- 1. As specified on plan sheets.
  - 2. Electrical Characteristics: As specified on plan sheets.
  - 3. Minimum Vent Diameter: Per manufacturer's recommendations and Liquefied Petroleum Gas Code, latest edition.

## 2.3 CIRCULATING PUMP

- A. Pump:
- 1. In line circulating pumps shall be horizontal, system lubricated and specifically designed for quiet operation in potable water applications.
  - 2. Pumps shall have an all bronze body and shall be suitable for 230F operation at 150 psig working pressure.
  - 3. Motors shall have built-in thermal overload protectors and shall be non-overloading at any point on the pump curve.
  - 4. The circulating pump shall be capable of supplying 10 GPM at a minimum of 8 ft TDH when powered by 115 volt, 60 hz, single phase electrical supply.
  - 5. The pump shall be Model NBF-22 as manufactured by ITT Bell & Gossett or approved equal.
- B. Automatic Timer:
- 1. The circulating pump shall be supplied with an integral automatic timer, programmable to turn the circulator ON and OFF automatically at preset times.
  - 2. The timer shall be Model TC-1 as manufactured by ITT Bell & Gossett or approved equal.
- C. Aquastat:
- 1. Aquastat shall be strap-on type with visible control point scale and external adjustment. Temperature range shall be adjustable from 65F to 200F.
  - 2. The aquastat shall provide ON and OFF control for the circulating pump.
  - 3. Aquastat shall be Model L6006C as manufactured by Honeywell Inc.
- D. Control:
- 1. The pump shall only circulate water when the ON time conditions are met and when water temperature is low enough to cause the aquastat to switch ON.

## 2.4 EXPANSION TANK

- A. Expansion tank shall be a pre-charged vertical, steel expansion tank with integral heavy duty butyl diaphragm and Polypropylene or butyl lined dome to completely isolate the water from the shell.
- B. The tank shall be approved for use with domestic potable water systems and designed for a maximum working pressure of 150 psi and maximum working temperature of 200F.
- C. The tank shall have 0.302"-32 charging valve connection (standard tire valve) to facilitate on-site charging of the tank.

## 2.5 WATER HEATER ACCESSORIES

- A. Gas Shutoff Valves: ANSI Z21.15/CGA 9.1, manually operated. Furnish for installation in piping.
- B. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1 or ASHRAE 90.2.

# PART 3 - EXECUTION

## 3.1 WATER HEATER INSTALLATION

- A. Install water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
- B. Install gas water heaters according to NFPA 58.
  - 1. Install gas shutoff valves on gas supplies to gas water heaters without shutoff valves.
  - 2. Install gas pressure regulators on gas supplies to gas water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.
  - 3. Install automatic gas valves on gas supplies to gas water heaters, if required for operation of safety control.
- C. Install combination temperature and pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial, water-heater, relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- D. Install water heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for water heaters that do not have tank drains. Refer to Division 22 Section "Domestic Water Piping Specialties" for hose-end drain valves.
- E. Install thermometer on outlet piping of water heaters. Refer to Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers.
- F. Install piping-type heat traps on inlet and outlet piping of water heater storage tanks without integral or fitting-type heat traps.



- G. Fill water heaters with water.

### 3.2 CONNECTIONS

- A. Install piping adjacent to water heaters to allow service and maintenance. Arrange piping for easy removal of water heaters.
- B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

### 3.3 FIELD QUALITY CONTROL

- A. Engage a factory-authorized service representative to inspect installation, including connections.
- B. Perform the following field tests and inspections:
  - 1. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
  - 2. Operational Test: After electrical circuitry has been energized, confirm proper operation.
  - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace water heaters that do not pass tests and inspections and retest as specified above.

### 3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial water heaters. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 223400

## **SECTION 224000 PLUMBING FIXTURES**

### **PART 1 - GENERAL**

#### **1.1 SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Operation and maintenance data.

#### **1.2 DEFINITIONS**

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.
- C. FRP: Fiberglass-reinforced plastic.
- D. PMMA: Polymethyl methacrylate (acrylic) plastic.
- E. PVC: Polyvinyl chloride plastic.
- F. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.

#### **1.3 QUALITY ASSURANCE**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.
- C. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
- D. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

## **PART 2 - PRODUCTS**

### **2.1 PLUMBING FIXTURES**

#### **A. Basis of Design:**

1. Provide product make and model listed in plumbing schedule on sheet P501. Equivalent products may be provided from the other manufacturers listed in the plumbing schedule.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.
- B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.
  1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
  2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
  3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.
- C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.
- D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.
- E. Install wall-mounting fixtures with tubular waste piping attached to supports.
- F. Install fixtures level and plumb according to roughing-in drawings.
- G. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
- H. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.
- I. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.
- J. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.
- K. Install toilet seats on water closets.
- L. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

- M. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.
- N. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- O. Install traps on fixture outlets:
  - 1. Exception: Omit trap on fixtures with integral traps.
  - 2. Exception: Omit trap on indirect wastes, unless otherwise indicated.
- P. Install disposer in outlet of each sink indicated to have disposer. Install switch where indicated or in wall adjacent to sink if location is not indicated.
- Q. Install dishwasher air-gap fitting at each sink indicated to have air-gap fitting. Install in sink deck. Connect inlet hose to dishwasher and outlet hose to disposer.
- R. Install escutcheons at piping wall and ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."
- S. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

### 3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

### 3.3 FIELD QUALITY CONTROL

- A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.
- B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.
- C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.
- D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

- E. Install fresh batteries in sensor-operated mechanisms.

### 3.4 PROTECTION

- A. Provide protective covering for installed fixtures and fittings.
- B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 224000

**SECTION 224700**  
**DRINKING FOUNTAINS AND WATER COOLERS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. This Section includes the following:
  - 1. Type PB, pressure with bubbler, Style W, wall-mounting water coolers.
  - 2. Fixture supports.

**1.2 SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Operation and maintenance data.

**1.3 QUALITY ASSURANCE**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for fixtures for people with disabilities.
- C. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
- D. ARI Standard: Comply with ARI's "Directory of Certified Drinking Water Coolers" for style classifications.
- E. ARI Standard: Comply with ARI 1010, "Self-Contained, Mechanically Refrigerated Drinking-Water Coolers," for water coolers and with ARI's "Directory of Certified Drinking Water Coolers" for type and style classifications.
- F. ASHRAE Standard: Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants" for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant unless otherwise indicated.

## PART 2 - PRODUCTS

### 2.1 PRESSURE WATER COOLERS

#### A. Water Coolers:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or an Architect/Engineer approved alternate:
  - a. Elkay Manufacturing Co.
2. Description: Accessible, ARI 1010, with bottle filling station, safety bubbler, wall-mounting water cooler for child and adult-mounting height.
  - a. Cabinet: Single, vinyl-covered steel with stainless-steel top.
  - b. Bubbler: One, with adjustable stream regulator, located on each cabinet deck.
  - c. Control: Electronic bottle filler sensor with electronic front and side bubbler pushbar.
  - d. Supply: NPS 3/8 with ball, gate, or globe valve.
  - e. Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate.
  - f. Drain(s): Grid with NPS 1-1/4 minimum horizontal waste and trap complying with ASME A112.18.1.
  - g. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
    - 1) Capacity: 8 gph of 50 deg F cooled water from 80 deg F inlet water and 90 deg F ambient air temperature.
    - 2) Electrical Characteristics: 325 Watts; 120-V ac; single phase; 60 Hz.
  - h. Support: Type I, water cooler carrier. Refer to "Fixture Supports" Article.

### 2.2 FIXTURE SUPPORTS

- #### A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Josam Co.
  2. MIFAB Manufacturing, Inc.
  3. Smith, Jay R. Mfg. Co.
  4. Tyler Pipe; Wade Div.
  5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
  6. Zurn Plumbing Products Group; Specification Drainage Operation.
- #### B. Description: ASME A112.6.1M, water cooler carriers. Include vertical, steel uprights with feet and tie rods and bearing plates with mounting studs matching fixture to be supported.
1. Type I: Hanger-type carrier with two vertical uprights.
  2. Type II: Bilevel, hanger-type carrier with three vertical uprights.
  3. Supports for Accessible Fixtures: Include rectangular, vertical, steel uprights instead of steel pipe uprights.

### **PART 3 - EXECUTION**

#### **3.1 APPLICATIONS**

- A. Use carrier off-floor supports for wall-mounting fixtures, unless otherwise indicated.
- B. Use chrome-plated brass or copper tube, fittings, and valves in locations exposed to view.

#### **3.2 INSTALLATION**

- A. Install off-floor supports affixed to building substrate and attach wall-mounting fixtures, unless otherwise indicated.
- B. Install fixtures level and plumb. For fixtures indicated for children, install at height required by authorities having jurisdiction.
- C. Install water-supply piping with shutoff valve on supply to each fixture to be connected to water distribution piping. Use ball, gate, or globe valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
- D. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
- E. Install pipe escutcheons at wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding pipe fittings. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."
- F. Seal joints between fixtures and walls and floors using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

#### **3.3 CONNECTIONS**

- A. Connect fixtures with water supplies, traps, and risers, and with soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

#### **3.4 FIELD QUALITY CONTROL**

- A. Water Cooler Testing: After electrical circuitry has been energized, test for compliance with requirements. Test and adjust controls and safeties.
  - 1. Remove and replace malfunctioning units and retest as specified above.
  - 2. Report test results in writing.



3.5 ADJUSTING

- A. Adjust fixture flow regulators for proper flow and stream height.
- B. Adjust water cooler temperature settings.

END OF SECTION 224700

**SECTION 230519**  
**METERS AND GAGES FOR HVAC PIPING**

**PART 1 - GENERAL**

1.1 SUMMARY

- A. Section Includes:
  - 1. Thermometers.
  - 2. Gages.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.

**PART 2 - PRODUCTS**

2.1 METAL-CASE, LIQUID-IN-GLASS THERMOMETERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - 1. Palmer - Wahl Instruments Inc.
  - 2. Trerice, H. O. Co.
  - 3. Weiss Instruments, Inc.
  - 4. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
- B. Case: Die-cast aluminum or brass, 9 inches long.
- C. Tube: Red or blue reading, mercury or organic-liquid filled, with magnifying lens.
- D. Tube Background: Satin-faced, nonreflective aluminum with permanently etched scale markings.
- E. Window: Glass.
- F. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.
- G. Stem: Copper-plated steel, aluminum, or brass for thermowell installation and of length to suit installation.
- H. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

## 2.2 DUCT-TYPE, LIQUID-IN-GLASS THERMOMETERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - 1. Miljoco Corp.
  - 2. Palmer - Wahl Instruments Inc.
  - 3. Trerice, H. O. Co.
  - 4. Weiss Instruments, Inc.
- B. Case: Die-cast aluminum, 7 inches long.
- C. Tube: Red or blue reading, mercury or organic filled, with magnifying lens.
- D. Tube Background: Satin-faced, nonreflective aluminum with permanently etched scale markings.
- E. Window: Glass or plastic.
- F. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.
- G. Stem: Metal, for installation in mounting bracket and of length to suit installation.
- H. Mounting Bracket: Flanged fitting for attachment to duct and made to hold thermometer stem.
- I. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

## 2.3 BIMETALLIC-ACTUATED DIAL THERMOMETERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - 1. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
  - 2. Ernst Gage Co.
  - 3. Eugene Ernst Products Co.
  - 4. Marsh Bellofram.
  - 5. Miljoco Corp.
  - 6. NANMAC Corporation.
  - 7. Noshok, Inc.
  - 8. Palmer - Wahl Instruments Inc.
  - 9. REO TEMP Instrument Corporation.
  - 10. Tel-Tru Manufacturing Company.
  - 11. Trerice, H. O. Co.
  - 12. Weiss Instruments, Inc.
  - 13. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
  - 14. WIKA Instrument Corporation.
  - 15. Winters Instruments.
- B. Description: Direct-mounting, bimetallic-actuated dial thermometers complying with ASME B40.3.
- C. Case: Liquid-filled type, stainless steel with 5-inch diameter.

- D. Element: Bimetal coil.
- E. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
- F. Pointer: Red metal.
- G. Window: Glass.
- H. Ring: Stainless steel.
- I. Connector: Adjustable angle type.
- J. Stem: Metal, for thermowell installation and of length to suit installation.
- K. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

## 2.4 THERMOWELLS

- A. Manufacturers: Same as manufacturer of thermometer being used.
- B. Description: Pressure-tight, socket-type metal fitting made for insertion into piping and of type, diameter, and length required to hold thermometer.

## 2.5 PRESSURE GAGES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - 1. AMETEK, Inc.; U.S. Gauge Div.
  - 2. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
  - 3. Ernst Gage Co.
  - 4. Eugene Ernst Products Co.
  - 5. KOBOLD Instruments, Inc.
  - 6. Marsh Bellofram.
  - 7. Miljoco Corp.
  - 8. Noshok, Inc.
  - 9. Palmer - Wahl Instruments Inc.
  - 10. REO TEMP Instrument Corporation.
  - 11. Terice, H. O. Co.
  - 12. Weiss Instruments, Inc.
  - 13. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
  - 14. WIKA Instrument Corporation.
  - 15. Winters Instruments.
- B. Direct-Mounting, Dial-Type Pressure Gages: Indicating-dial type complying with ASME B40.100.
  - 1. Case: Liquid-filled type, drawn steel or cast aluminum, 4-1/2-inch diameter.
  - 2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
  - 3. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.
  - 4. Movement: Mechanical, with link to pressure element and connection to pointer.

5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
6. Pointer: Red metal.
7. Window: Glass.
8. Ring: Stainless steel.
9. Accuracy: Grade B, plus or minus 2 percent of middle half scale.
10. Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure.
11. Range for Fluids under Pressure: Two times operating pressure.

C. Pressure-Gage Fittings:

1. Valves: NPS 1/4 brass or stainless-steel needle type.
2. Syphons: NPS 1/4 coil of brass tubing with threaded ends.
3. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

## **PART 3 - EXECUTION**

### **3.1 THERMOMETER APPLICATIONS**

A. Install liquid-in-glass thermometers in the following locations:

1. Inlet and outlet of each hydronic zone.
2. Inlet and outlet of each hydronic boiler and chiller.
3. Inlet and outlet of each hydronic coil in air-handling units and built-up central systems.
4. Outside-air, return-air, and mixed-air ducts.

B. Install liquid-filled-case-type, bimetallic-actuated dial thermometers at suction and discharge of each pump.

C. Provide the following temperature ranges for thermometers:

1. Heating Hot Water: 30 to 240 deg F, with 2-degree scale divisions.
2. Chilled Water: 0 to 160 deg F, with 2-degree scale divisions.
3. Air Ducts: 30 to 240 deg F, with 2-degree scale divisions.

### **3.2 GAGE APPLICATIONS**

A. Install dry-case-type pressure gages for discharge of each pressure-reducing valve.

B. Install liquid-filled-case-type pressure gages at chilled- and condenser-water inlets and outlets of chillers.

C. Install liquid-filled-case-type pressure gages at suction and discharge of each pump.

### **3.3 INSTALLATIONS**

A. Install direct-mounting thermometers and adjust vertical and tilted positions.

B. Install thermowells with socket extending one-third of diameter of pipe and in vertical position in piping tees where thermometers are indicated.

- C. Duct Thermometer Support Flanges: Install in wall of duct where duct thermometers are indicated. Attach to duct with screws.
- D. Install direct-mounting pressure gages in piping tees with pressure gage located on pipe at most readable position.
- E. Install needle-valve and snubber fitting in piping for each pressure gage for fluids (except steam).
- F. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters as prescribed by manufacturer's written instructions.
- G. Install flowmeter elements in accessible positions in piping systems.
- H. Install differential-pressure-type flowmeter elements with at least minimum straight lengths of pipe upstream and downstream from element as prescribed by manufacturer's written instructions.
- I. Install connection fittings for attachment to portable indicators in accessible locations.

#### 3.4 CONNECTIONS

- A. Install meters and gages adjacent to machines and equipment to allow service and maintenance for meters, gages, machines, and equipment.
- B. Connect flowmeter-system elements to meters.

#### 3.5 ADJUSTING

- A. Calibrate meters according to manufacturer's written instructions, after installation.
- B. Adjust faces of meters and gages to proper angle for best visibility.

END OF SECTION 230519

**SECTION 230523**  
**GENERAL DUTY VALVES FOR HVAC PIPING**

**PART 1 - GENERAL**

1.1 SUMMARY

A. Section Includes:

1. Brass ball valves.
2. Bronze ball valves.
3. Iron, single-flange butterfly valves.
4. Bronze swing check valves.
5. Iron swing check valves.
6. Bronze globe valves.
7. Iron globe valves.

1.2 SUBMITTALS

- A. Product Data: For each type of valve indicated.

1.3 QUALITY ASSURANCE

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance: ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.

**PART 2 - PRODUCTS**

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- B. Valve Sizes: Same as upstream piping unless otherwise indicated.
- C. Valve Actuator Types:
1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
  2. Handwheel: For valves other than quarter-turn types.
  3. Handlever: For quarter-turn valves NPS 6 and smaller.
- D. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
1. Gate Valves: With rising stem.
  2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

3. Butterfly Valves: With extended neck.

E. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Solder Joint: With sockets according to ASME B16.18.
3. Threaded: With threads according to ASME B1.20.1.

## 2.2 BRASS BALL VALVES

A. Two-Piece, Full-Port, Brass Ball Valves with Stainless-Steel Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Crane Co.; Crane Valve Group; Crane Valves.
  - b. Crane Co.; Crane Valve Group; Jenkins Valves.
  - c. Flow-Tek, Inc.; a subsidiary of Bray International, Inc.
  - d. Hammond Valve.
  - e. Jamesbury; a subsidiary of Metso Automation.
  - f. Kitz Corporation.
  - g. Marwin Valve; a division of Richards Industries.
  - h. Milwaukee Valve Company.
  - i. RuB Inc.
2. Description:
  - a. Standard: MSS SP-110.
  - b. SWP Rating: 150 psig.
  - c. CWP Rating: 600 psig.
  - d. Body Design: Two piece.
  - e. Body Material: Forged brass.
  - f. Ends: Flanged, solder joint, or threaded.
  - g. Seats: PTFE or TFE.
  - h. Stem: Stainless steel.
  - i. Ball: Stainless steel, vented.
  - j. Port: Full.

## 2.3 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Conbraco Industries, Inc.; Apollo Valves.
  - b. Crane Co.; Crane Valve Group; Crane Valves.
  - c. Hammond Valve.
  - d. Lance Valves; a division of Advanced Thermal Systems, Inc.
  - e. Milwaukee Valve Company.
  - f. NIBCO INC.
  - g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:



- a. Standard: MSS SP-110.
- b. SWP Rating: 150 psig.
- c. CWP Rating: 600 psig.
- d. Body Design: Two piece.
- e. Body Material: Bronze.
- f. Ends: Flanged, solder joint, or threaded.
- g. Seats: PTFE or TFE.
- h. Stem: Stainless steel.
- i. Ball: Stainless steel, vented.
- j. Port: Full.

## 2.4 BRONZE SWING CHECK VALVES

### A. Class 150, Bronze Swing Check Valves with Bronze Disc:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. American Valve, Inc.
  - b. Crane Co.; Crane Valve Group; Crane Valves.
  - c. Crane Co.; Crane Valve Group; Jenkins Valves.
  - d. Crane Co.; Crane Valve Group; Stockham Division.
  - e. Kitz Corporation.
  - f. Milwaukee Valve Company.
  - g. NIBCO INC.
  - h. Red-White Valve Corporation.
  - i. Zy-Tech Global Industries, Inc.
- 2. Description:
  - a. Standard: MSS SP-80, Type 3.
  - b. CWP Rating: 300 psig.
  - c. Body Design: Horizontal flow.
  - d. Body Material: ASTM B 62, bronze.
  - e. Ends: Threaded.
  - f. Disc: Bronze.

## 2.5 BRONZE GLOBE VALVES

### A. Class 150, Bronze Globe Valves with Nonmetallic Disc:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Crane Co.; Crane Valve Group; Crane Valves.
  - b. Hammond Valve.
  - c. Kitz Corporation.
  - d. Milwaukee Valve Company.
  - e. NIBCO INC.
  - f. Powell Valves.
  - g. Red-White Valve Corporation.
  - h. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
  - i. Zy-Tech Global Industries, Inc.

2. Description:

- a. Standard: MSS SP-80, Type 2.
- b. CWP Rating: 300 psig.
- c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
- d. Ends: Threaded.
- e. Stem: Bronze.
- f. Disc: PTFE or TFE.
- g. Packing: Asbestos free.
- h. Handwheel: Malleable iron.

**PART 3 - EXECUTION**

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install swing check valves for proper direction of flow and in horizontal position with hinge pin level.

3.3 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

### 3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
  - 1. Shutoff Service: Ball valves for NPS 2-1/2 and smaller.
  - 2. Shutoff Service: Ball valves for NPS 3 and larger.
  - 3. Throttling Service, Except Steam: Globe or ball valves.
  - 4. Pump-Discharge Check Valves:
    - a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.
    - b. NPS 2-1/2 and Larger: Iron swing check valves with lever and weight or with spring.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- C. Select valves, except wafer types, with the following end connections:
  - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
  - 2. For Steel Piping, NPS 2 and Smaller: Threaded ends.
  - 3. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
  - 4. For Steel Piping, NPS 5 and Larger: Flanged ends.

END OF SECTION 230523

## **SECTION 230529**

### **HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT**

#### **PART 1 - GENERAL**

##### **1.1 SUMMARY**

- A. This Section includes the following hangers and supports for HVAC system piping and equipment:
  - 1. Steel pipe hangers and supports.
  - 2. Trapeze pipe hangers.
  - 3. Metal framing systems.
  - 4. Thermal-hanger shield inserts.
  - 5. Fastener systems.
  - 6. Equipment supports.

##### **1.2 PERFORMANCE REQUIREMENTS**

- A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

##### **1.3 QUALITY ASSURANCE**

- A. Welding: Qualify procedures and personnel according to the following:
  - 1. AWS D1.1, "Structural Welding Code--Steel."
  - 2. AWS D1.2, "Structural Welding Code--Aluminum."
  - 3. AWS D1.3, "Structural Welding Code--Sheet Steel."
  - 4. AWS D1.4, "Structural Welding Code--Reinforcing Steel."

#### **PART 2 - PRODUCTS**

##### **2.1 STEEL PIPE HANGERS AND SUPPORTS**

- A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
- B. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.
- C. Nonmetallic Coatings: Plastic coating, jacket, or liner.
- D. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

## 2.2 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

## 2.3 METAL FRAMING SYSTEMS

- A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
- B. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.
- C. Nonmetallic Coatings: Plastic coating, jacket, or liner.

## 2.4 THERMAL-HANGER SHIELD INSERTS

- A. Description: 100-psig- minimum, compressive-strength insulation insert encased in sheet metal shield.
- B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with vapor barrier.
- C. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass.
- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

## 2.5 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

## 2.6 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

## 2.7 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
  - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
  - 2. Design Mix: 5000-psi, 28-day compressive strength.

## **PART 3 - EXECUTION**

### **3.1 HANGER AND SUPPORT APPLICATIONS**

- A. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
- B. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.
- C. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- D. Use padded hangers for piping that is subject to scratching.
- E. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
- F. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
  - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
- G. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
  - 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
  - 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
  - 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
  - 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- H. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
  - 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.

3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
  4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
  5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
  6. C-Clamps (MSS Type 23): For structural shapes.
  7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
  8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
  9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
  10. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
  11. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    - a. Light (MSS Type 31): 750 lb .
    - b. Medium (MSS Type 32): 1500 lb.
    - c. Heavy (MSS Type 33): 3000 lb.
  12. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
- I. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
  2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
  3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- J. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
  2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
  3. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
  4. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
  5. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
  6. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
    - a. Horizontal (MSS Type 54): Mounted horizontally.
    - b. Vertical (MSS Type 55): Mounted vertically.
    - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

- K. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.
- L. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
- M. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

### 3.2 HANGER AND SUPPORT INSTALLATION

- A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
  - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
  - 2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
- D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation:
  - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
  - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- I. Install lateral bracing with pipe hangers and supports to prevent swaying in building areas constructed to meet the FEMA 361 standards.
- J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and



larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

- K. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.
- M. Insulated Piping: Comply with the following:
  - 1. Attach clamps and spacers to piping.
    - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
    - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    - c. Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.
  - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
    - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
  - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
    - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
  - 4. Shield Dimensions for Pipe: Not less than the following:
    - a. NPS 1/4 to NPS 4: 12 inches long and 0.048 inch thick.
  - 5. Insert Material: Length at least as long as protective shield.
  - 6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

### 3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make smooth bearing surface.
- C. Provide lateral bracing, to prevent swaying, for equipment supports in building areas constructed to meet the FEMA 361 standards.

### 3.4 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove welding flux immediately.
  - 4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

### 3.5 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

### 3.6 PAINTING

- A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
  - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 230529

**SECTION 230553**  
**IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT**

**PART 1 - GENERAL**

1.1 SUMMARY

- A. Section Includes:
1. Equipment labels.
  2. Warning signs and labels.
  3. Pipe labels.
  4. Duct labels.
  5. Valve tags.

1.2 SUBMITTAL

- A. Product Data: For each type of product indicated.

1.3 QUALITY ASSURANCE

- A. Handwritten identification for HVAC piping and equipment is specifically prohibited.

**PART 2 - PRODUCTS**

2.1 EQUIPMENT LABELS

- A. Plastic Labels for Equipment:
1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
  2. Letter Color: Black Blue Red White Yellow Insert color.
  3. Background Color: White.
  4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
  5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
  6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
  7. Fasteners: Stainless-steel rivets or self-tapping screws.
  8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's Drawing designation or unique equipment number.

## 2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: White.
- C. Background Color: Yellow Insert color.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information, plus emergency notification instructions.

## 2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
  - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
  - 2. Lettering Size: At least 1-1/2 inches high.

## 2.4 DUCT LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: White.
- C. Background Color: Black.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.
  - 1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.
  - 2. Lettering Size: At least 1-1/2 inches high.

## 2.5 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
  - 1. Tag Material: Stainless steel, 0.025-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
  - 2. Fasteners: Brass beaded chain.
- B. Label Content: Include valve's Drawing designation.

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. Contractor is responsible for labeling pipe, equipment, duct, and valves installed or modified as part of this project.

### 3.2 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

### 3.3 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

### 3.4 PIPE LABEL INSTALLATION

- A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
1. Near each valve and control device.
  2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
  3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
  4. At access doors, manholes, and similar access points that permit view of concealed piping.
  5. Near major equipment items and other points of origination and termination.
  6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
  7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- B. Pipe Label Color Schedule:
1. Chilled-Water Piping:
    - a. Background Color: Blue.
    - b. Letter Color: White.
  2. Heating Water Piping:
    - a. Background Color: Yellow.
    - b. Letter Color: Red.
  3. Refrigerant Piping:
    - a. Background Color: Green.
    - b. Letter Color: White.

### 3.5 DUCT LABEL INSTALLATION

- A. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:
1. Blue: For supply-air ducts.
  2. Yellow: For return-air ducts.
  3. Green: For outside-air ducts.
  4. Red: For exhaust-air ducts.
- B. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

### 3.6 VALVE TAG INSTALLATION

- A. Install valve tags on all valves that are identified with a unique designation on the Drawings.

END OF SECTION 230553

**SECTION 230593**  
**TESTING, ADJUSTING, AND BALANCING FOR HVAC**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. This Section includes TAB to produce design objectives for the following:
  - 1. Air Systems:
    - a. Constant-volume air systems.
    - b. Variable-air-volume systems.
  - 2. Hydronic Piping Systems:
    - a. Variable-flow systems.
  - 3. Verifying that automatic control devices are functioning properly.
  - 4. Reporting results of activities and procedures specified in this Section.

**1.2 DEFINITIONS**

- A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.
- B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.
- C. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.
- D. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.
- E. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.
- F. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
- G. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.
- H. TAB: Testing, adjusting, and balancing.
- I. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

- J. Test: A procedure to determine quantitative performance of systems or equipment.
- K. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

### 1.3 SUBMITTALS

- A. Qualification Data: Within 45 days from Contractor's Notice to Proceed, submit 4 copies of evidence that TAB firm and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Certified TAB Reports: Submit electronic copies of reports prepared, as specified in this Section.

### 1.4 QUALITY ASSURANCE

- A. TAB Firm Qualifications:
  - 1. Certified by AABC, NEBB, or TABB.
  - 2. Minimum TAB experience of 5 years.
- B. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:
  - 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
  - 2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.
- C. TAB Report Forms: Use standard forms from TAB firm's forms approved by Architect.
- D. Instrumentation Type, Quantity, and Accuracy: As described in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."
- E. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.
  - 1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

### 1.5 COORDINATION

- A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.



## **PART 2 - PRODUCTS (Not Applicable)**

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
- B. Examine approved submittal data of HVAC systems and equipment.
- C. Examine equipment performance data including fan and pump curves.
- D. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.
- E. Examine system and equipment test reports.
- F. Examine HVAC system and equipment installations to verify that indicated balancing devices are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- G. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.
- H. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- I. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- J. Examine equipment for installation and for properly operating safety interlocks and controls.
- K. Examine automatic temperature system components to verify the following:
  - 1. Dampers, valves, and other controlled devices are operated by the intended controller.
  - 2. Dampers and valves are in the position indicated by the controller.
  - 3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
  - 4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
  - 5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
  - 6. Sensors are located to sense only the intended conditions.
  - 7. Sequence of operation for control modes is according to the Contract Documents.
  - 8. Controller set points are set at indicated values.
  - 9. Interlocked systems are operating.
  - 10. Changeover from heating to cooling mode occurs according to indicated values.
- L. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

### 3.2 PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures.
- B. Complete system readiness checks and prepare system readiness reports. Verify the following:
  - 1. Permanent electrical power wiring is complete.
  - 2. Automatic temperature-control systems are operational.
  - 3. Equipment and duct access doors are securely closed.
  - 4. Balance, smoke, and fire dampers are open.
  - 5. Isolating and balancing valves are open and control valves are operational.
  - 6. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
  - 7. Windows and doors can be closed so indicated conditions for system operations can be met.

### 3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems", NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems", or SMACNA's TABB "HVAC Systems - Testing, Adjusting, and Balancing" and this Section.
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.
- C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

### 3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. For variable-air-volume systems, develop a plan to simulate diversity.
- C. Determine the best locations in main and branch ducts for accurate duct airflow measurements.
- D. Check airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.
- E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- F. Verify that motor starters are equipped with properly sized thermal protection.
- G. Check dampers for proper position to achieve desired airflow path.

- H. Check for airflow blockages.
- I. Check condensate drains for proper connections and functioning.
- J. Check for proper sealing of air-handling unit components.
- K. Check for proper sealing of air duct system.

### 3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
  - 1. Measure the total supply airflow at the unit using a pitot-tube traverse.
  - 2. Measure fan static pressures to determine actual static pressure as follows:
    - a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
    - b. Measure static pressure directly at the fan outlet or through the flexible connection.
    - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
    - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
  - 3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
    - a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.
  - 4. Measure static pressures under final balanced conditions.
  - 5. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
  - 6. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.
  - 7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full cooling, full heating, economizer, and any other operating modes to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
  - 1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.

- a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
  2. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
- C. Measure terminal outlets and inlets without making adjustments.
1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- D. Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using volume dampers rather than extractors and the dampers at air terminals.
1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
  2. Adjust patterns of adjustable outlets for proper distribution without drafts.

### 3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

- A. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
1. Set outside-air dampers at minimum, and return- and exhaust-air dampers at a position that simulates full-cooling load.
  2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
  3. Measure total system airflow. Adjust to within indicated airflow.
  4. Measure the total supply airflow at the unit using a pitot-tube traverse.
  5. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
  6. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow as described for constant-volume air systems.
    - a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.
  7. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.
  8. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
  9. Record the final fan performance data.

### 3.7 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer, model, and serial numbers.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

### 3.8 PROCEDURES FOR CONDENSER UNITS

A. Verify proper rotation of fans.

### 3.9 PROCEDURES FOR HEAT-TRANSFER COILS

A. Hydronic Coils: Measure the following data for each coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Fluid inlet and outlet temperatures.

### 3.10 PROCEDURES FOR CHILLERS

A. Balance water flow through each evaporator and condenser to within specified tolerances of indicated flow with all pumps operating. With only one chiller operating in a multiple chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:

1. Evaporator-water entering and leaving temperatures, pressure drop, and water flow.
2. If water-cooled chillers, condenser-water entering and leaving temperatures, pressure drop, and water flow.
3. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.
4. Power factor if factory-installed instrumentation is furnished for measuring kilowatt.
5. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatt.
6. Capacity: Calculate in tons of cooling.

### 3.11 PROCEDURES FOR PRESSURE CONTROL VALVES

- A. Keep pressure control valves in the fully closed position until the primary pumps have reached their minimum specified pump speed.
- B. Measure the primary loop differential pressure.
- C. Once the primary pumps have reached their minimum specified pump speed, begin to open the pressure control valve to maintain the previously measured primary loop differential pressure setpoint. Measure flow in the primary loop supply and return pipes to ensure they are equal.

### 3.12 TEMPERATURE-CONTROL VERIFICATION

- A. Verify that controllers are calibrated and commissioned.
- B. Check transmitter and controller locations and note conditions that would adversely affect control functions.
- C. Record controller settings and note variances between set points and actual measurements.
- D. Check the operation of limiting controllers (i.e., high- and low-temperature controllers).
- E. Check free travel and proper operation of control devices such as damper and valve operators.
- F. Check the sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water flow measurements. Note the speed of response to input changes.
- G. Check the interaction of electrically operated switch transducers.
- H. Check the interaction of interlock and lockout systems.
- I. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or nongrounded power supply.
- J. Note operation of electric actuators using spring return for proper fail-safe operations.

### 3.13 TOLERANCES

- A. Set HVAC system airflow and water flow rates within the following tolerances:
  - 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 5 to plus 10 percent.
  - 2. Air Outlets and Inlets: 0 to minus 10 percent.
  - 3. Heating-Water Flow Rate: 0 to minus 10 percent.
  - 4. Cooling-Water Flow Rate: 0 to minus 5 percent.

### 3.14 FINAL REPORT

- A. General: Electronic copy in letter-quality font.

- B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
  - 1. Include a list of instruments used for procedures, along with proof of calibration.
- C. Final Report Contents: In addition to certified field report data, include the following:
  - 1. Pump curves.
  - 2. Fan curves.
  - 3. Manufacturers' test data.
  - 4. Field test reports prepared by system and equipment installers.
  - 5. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.
- D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:
  - 1. Title page.
  - 2. Name and address of TAB firm.
  - 3. Project name.
  - 4. Project location.
  - 5. Architect's name and address.
  - 6. Engineer's name and address.
  - 7. Contractor's name and address.
  - 8. Report date.
  - 9. Signature of TAB firm who certifies the report.
  - 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
  - 11. Summary of contents including the following:
    - a. Indicated versus final performance.
    - b. Notable characteristics of systems.
    - c. Description of system operation sequence if it varies from the Contract Documents.
  - 12. Nomenclature sheets for each item of equipment.
  - 13. Notes to explain why certain final data in the body of reports varies from indicated values.
  - 14. Test conditions for fans and pump performance forms including the following:
    - a. Settings for outside-, return-, and exhaust-air dampers.
    - b. Conditions of filters.
    - c. Cooling coil, wet- and dry-bulb conditions.
    - d. Fan drive settings including settings and percentage of maximum pitch diameter.
    - e. Inlet vane settings for variable-air-volume systems.
    - f. Settings for supply-air, static-pressure controller.
    - g. Any other system operating conditions that affect performance.
- E. Air-Handling Unit Test Reports: For air-handling units with coils, include the following:
  - 1. Unit Data: Include the following:
    - a. Unit identification.
    - b. Location.
    - c. Make and type.
    - d. Model number and unit size.

- e. Manufacturer's serial number.
- f. Unit arrangement and class.
- g. Discharge arrangement.
- h. Sheave make, size in inches, and bore.
- i. Sheave dimensions, center-to-center, and amount of adjustments in inches.
- j. Number of belts, make, and size.
- k. Number of filters, type, and size.

2. Motor Data:

- a. Make and frame type and size.
- b. Horsepower and rpm.
- c. Volts, phase, and hertz.
- d. Full-load amperage and service factor.
- e. Sheave make, size in inches, and bore.
- f. Sheave dimensions, center-to-center, and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):

- a. Total airflow rate in cfm (measured at unit discharge)
- b. Total airflow rate in cfm (summation of air terminals)
- c. Total system static pressure in inches wg.
- d. Fan rpm.
- e. Discharge static pressure in inches wg .
- f. Filter static-pressure differential in inches wg.
- g. Preheat coil static-pressure differential in inches wg.
- h. Cooling coil static-pressure differential in inches wg.
- i. Heating coil static-pressure differential in inches wg.
- j. Outside airflow in cfm.
- k. Return airflow in cfm.
- l. Outside-air damper position.
- m. Return-air damper position.
- n. Vortex damper position.

F. Apparatus-Coil Test Reports:

1. Coil Data:

- a. System identification.
- b. Location.
- c. Coil type.
- d. Number of rows.
- e. Fin spacing in fins per inch o.c.
- f. Make and model number.
- g. Face area in sq. ft..
- h. Tube size in NPS.
- i. Tube and fin materials.
- j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

- a. Airflow rate in cfm.
- b. Average face velocity in fpm.



- c. Air pressure drop in inches wg.
  - d. Outside-air, wet- and dry-bulb temperatures in deg F.
  - e. Return-air, wet- and dry-bulb temperatures in deg F.
  - f. Entering-air, wet- and dry-bulb temperatures in deg F.
  - g. Leaving-air, wet- and dry-bulb temperatures in deg F.
  - h. Refrigerant expansion valve and refrigerant types.
  - i. Refrigerant suction pressure in psig.
  - j. Refrigerant suction temperature in deg F.
- G. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
  - 1. Report Data:
    - a. System and air-handling unit number.
    - b. Location and zone.
    - c. Traverse air temperature in deg F.
    - d. Duct static pressure in inches wg.
    - e. Duct size in inches.
    - f. Duct area in sq. ft..
    - g. Indicated airflow rate in cfm.
    - h. Indicated velocity in fpm.
    - i. Actual airflow rate in cfm.
    - j. Actual average velocity in fpm.
- H. Air-Terminal-Device Reports:
  - 1. Unit Data:
    - a. System and air-handling unit identification.
    - b. Location and zone.
    - c. Test apparatus used.
    - d. Area served.
    - e. Air-terminal-device make.
    - f. Air-terminal-device number from system diagram.
    - g. Air-terminal-device type and model number.
    - h. Air-terminal-device size.
  - 2. Test Data (Indicated and Actual Values):
    - a. Airflow rate in cfm.
    - b. Preliminary airflow rate as needed in cfm.
    - c. Final airflow rate in cfm.
- I. Compressor and Condenser Reports: For refrigerant side of unitary systems, stand-alone refrigerant compressors, air-cooled condensing units, or water-cooled condensing units, include the following:
  - 1. Unit Data:
    - a. Unit identification.
    - b. Location.
    - c. Unit make and model number.
    - d. Refrigerant weight in lb.
    - e. Low ambient temperature cutoff in deg F.

2. Test Data (Indicated and Actual Values):

- a. Entering-air, dry-bulb temperature in deg F.
- b. Leaving-air, dry-bulb temperature in deg F.
- c. Control settings.
- d. Low-pressure-cutout set point in psig.
- e. High-pressure-cutout set point in psig.
- f. Suction pressure in psig.
- g. Suction temperature in deg F.
- h. Condenser refrigerant pressure in psig.
- i. Condenser refrigerant temperature in deg F.
- j. Oil pressure in psig.
- k. Oil temperature in deg F.
- l. Voltage at each connection.
- m. Amperage for each phase.
- n. Kilowatt input.
- o. Number of fans.
- p. Condenser fan rpm.
- q. Condenser fan airflow rate in cfm.
- r. Condenser fan motor make, frame size, rpm, and horsepower.
- s. Condenser fan motor voltage at each connection.
- t. Condenser fan motor amperage for each phase.

J. Air-to-Air Heat-Recovery Unit Reports:

1. Unit Data:

- a. Unit identification.
- b. Location.
- c. Service.
- d. Make and type.
- e. Model and serial numbers.

2. Motor Data:

- a. Make and frame type and size.
- b. Horsepower and rpm.
- c. Volts, phase, and hertz.
- d. Full load amperage and service factor.
- e. Sheave make, size in inches, and bore.
- f. Sheave dimensions, center-to-center, and amount of adjustments in inches.

3. If fans are an integral part of the unit, include the following for each fan:

- a. Make and type.
- b. Arrangement and size.
- c. Sheave make, size in inches, and bore.
- d. Sheave dimensions, center-to-center, and amount of adjustments in inches.

4. Test Data (Indicated and Actual Values):

- a. Total exhaust airflow rate in cfm.
- b. Purge exhaust airflow rate in cfm.
- c. Outside airflow rate in cfm.
- d. Total exhaust fan static pressure in inches wg.

- e. Total outside-air fan static pressure in inches wg.
- f. Pressure drop on each side of recovery wheel in inches wg.
- g. Exhaust air temperature entering in deg F.
- h. Exhaust air temperature leaving in deg F.
- i. Outside-air temperature entering in deg F.
- j. Outside-air temperature leaving in deg F.
- k. Calculate sensible and total heat capacity of each airstream in MBh.

K. Instrument Calibration Reports:

1. Report Data:

- a. Instrument type and make.
- b. Serial number.
- c. Application.
- d. Dates of use.
- e. Dates of calibration.

3.15 INSPECTIONS

A. Initial Inspection:

- 1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the Final Report.
- 2. Randomly check the following for each system:
  - a. Measure airflow of at least 10 percent of air outlets.
  - b. Measure water flow of at least 5 percent of terminals.
  - c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
  - d. Verify that balancing devices are marked with final balance position.
  - e. Note deviations to the Contract Documents in the Final Report.

B. Final Inspection:

- 1. After initial inspection is complete and evidence by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Engineer.
- 2. TAB firm test and balance engineer shall conduct the inspection in the presence of Engineer.
- 3. Engineer shall randomly select measurements documented in the final report to be rechecked. The rechecking shall be limited to either 10 percent of the total measurements recorded, or the extent of measurements that can be accomplished in a normal 8-hour business day.
- 4. If the rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
- 5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
- 6. TAB firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final report.

7. Request a second final inspection. If the second final inspection also fails, Owner shall contract the services of another TAB firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment.

END OF SECTION 230593

## SECTION 230700

### HVAC INSULATION

#### PART 1 - GENERAL

##### 1.1 SUMMARY

- A. Section Includes:
  - 1. Insulation Materials:
    - a. Flexible elastomeric.
    - b. Mineral fiber.
  - 2. Adhesives.
  - 3. Mastics.
  - 4. Sealants.
  - 5. Tapes.
  - 6. Securements.

##### 1.2 SUBMITTALS

- A. Product Data: Include thermal conductivity, thickness, and jackets (both factory and field applied) for each type of product indicated.

##### 1.3 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
  - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
  - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

##### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade, and maximum use temperature.

##### 1.5 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields.
- B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation

application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

## 1.6 SCHEDULING

- A. Schedule insulation application after testing piping systems. Insulation application may begin on segments of piping that have satisfactory test results.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Mineral-Fiber Insulation:
    - a. CertainTeed Manson.
    - b. Knauf FiberGlass GmbH.
    - c. Owens-Corning Fiberglas Corp.
    - d. Schuller International, Inc.

### 2.2 INSULATION MATERIALS

- A. Mineral-Fiber Insulation: Glass fibers bonded with a thermosetting resin complying with the following:
  - 1. Preformed Pipe Insulation: Comply with ASTM C547, Type 1, with factory-applied, all-purpose, vapor-retarder jacket.
  - 2. Fire-Resistant Adhesive: Comply with MIL-A-3316C in the following classes and grades:
    - a. Class 1, Grade A for bonding glass cloth and tape to unfaced glass-fiber insulation, for sealing edges of glass-fiber insulation, and for bonding lagging cloth to unfaced glass-fiber insulation.
    - b. Class 2, Grade A for bonding glass-fiber insulation to metal surfaces.
  - 3. Vapor-Retarder Mastics: Fire- and water-resistant, vapor-retarder mastic for indoor applications. Comply with MIL-C-19565C, Type II.
  - 4. Mineral-Fiber Insulating Cements: Comply with ASTM C195.
  - 5. Expanded or Exfoliated Vermiculite Insulating Cements: Comply with ASTM C196.
  - 6. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C499/C 499M.

### 2.3 INTERIOR PIPING INSULATION JACKETS

- A. General: ASTM C921, Type 1, unless otherwise indicated.
- B. Heavy Duty PVC Jackets on all piping within 10ft of finished floor in mechanical room.

- C. Heavy Duty PVC Fitting Covers: Factory-fabricated fitting covers manufactured from 20-mil-(0.5-mm-) thick, high-impact, ultraviolet-resistant PVC.
  - 1. Shapes: 45- and 90- degree, short- and long-radius elbows, tees, valves, flanges, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories for the disabled.
  - 2. Adhesive: As recommended by insulation material manufacturer.

## 2.4 EXTERIOR PIPING INSULATION JACKETS

- A. General: ASTM C1729, Aluminum-alloy, smooth finish, unless otherwise indicated.
- B. All exterior piping to be provided with Aluminum-Alloy jacketing.
- C. Aluminum-Alloy Fitting Covers: Factory-fabricated fitting covers manufactured from 0.016-inch (0.41-mm-) thick, aluminum-alloy.
  - 1. Shapes: 45- and 90- degree, short- and long-radius elbows, tees, valves, flanges, reducers, end caps, traps, mechanical joints, and P-trap.
  - 2. Adhesive: As recommended by insulation material manufacturer.

## 2.5 ACCESSORIES AND ATTACHMENTS

- A. Glass Cloth and Tape: Comply with MIL-C-20079H, Type I for cloth and Type II for tape. Woven glass-fiber fabrics, plain weave, pre-sized a minimum of 8 oz./sq.yd.
  - 1. Tape Width: 4 inches.
- B. Bands: 3/4 inch wide, in one of the following materials compatible with jacket:
  - 1. Stainless Steel: ASTM A 666, Type 304; 0.020 inch thick.
  - 2. Galvanized Steel: 0.005 inch thick.
  - 3. Aluminum: 0.007 inch thick.
  - 4. Brass: 0.010 inch thick.
  - 5. Nickel-Copper Alloy: 0.005 inch thick.
- C. Wire: 0.080-inch, nickel-copper alloy; 0.062-inch, soft annealed, stainless steel; or 0.062-inch, soft-annealed, galvanized steel.

## 2.6 VAPOR RETARDERS

- A. Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

## 2.7 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.

- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
- D. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
- E. PVC Jacket Adhesive: Compatible with PVC jacket.

## 2.8 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
- B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
  - 1. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
  - 2. Service Temperature Range: Minus 20 to plus 180 deg F.
  - 3. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
  - 4. Color: White.

## 2.9 SEALANTS

- A. PVC Jacket Flashing Sealants:
  - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
  - 2. Fire- and water-resistant, flexible, elastomeric sealant.
  - 3. Service Temperature Range: Minus 40 to plus 250 deg F.
  - 4. Color: White.

## 2.10 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
  - 1. Width: 3 inches.
  - 2. Thickness: 11.5 mils.
  - 3. Adhesion: 90 ounces force/inch in width.
  - 4. Elongation: 2 percent.
  - 5. Tensile Strength: 40 lbf/inch in width.
  - 6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
  - 1. Width: 3 inches.
  - 2. Thickness: 6.5 mils.
  - 3. Adhesion: 90 ounces force/inch in width.
  - 4. Elongation: 2 percent.
  - 5. Tensile Strength: 40 lbf/inch in width.
  - 6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.



- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
  - 1. Width: 2 inches.
  - 2. Thickness: 6 mils.
  - 3. Adhesion: 64 ounces force/inch in width.
  - 4. Elongation: 500 percent.
  - 5. Tensile Strength: 18 lbf/inch in width.

## 2.11 SECUREMENTS

- A. Insulation Pins and Hangers:
  - 1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch or 0.135-inch diameter shank, length to suit depth of insulation indicated.
  - 2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch or 0.135-inch diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
  - 3. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
    - a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
  - 4. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
  - 1. Verify that systems and equipment to be insulated have been tested and are free of defects.
  - 2. Verify that surfaces to be insulated are clean and dry.
  - 3. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

### 3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Apply insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.
- B. Apply insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.
- C. Use accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Apply insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Apply multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.
- H. Keep insulation materials dry during application and finishing.
- I. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- J. Apply insulation with least number of joints practical.
- K. Apply insulation over fittings, valves, and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated. Refer to special instruction for applying insulation over fittings, valves, and specialties.
- L. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic.
  - 1. Apply insulation continuously through hangers and around anchor attachments.
  - 2. For insulation application where vapor retarders are indicated, extend insulation on anchor legs at least 12 inches from point of attachment to pipe and taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
  - 3. Install insert materials and apply insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by the insulation material manufacturer.
  - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shield over jacket, arranged to protect the jacket from tear or puncture by the hanger, support, and shield.

- M. Insulation Terminations: For insulation application where vapor retarders are indicated, taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
- N. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
  - 1. Install insulation continuously through hangers and around anchor attachments.
  - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
  - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
  - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- O. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- P. Install insulation with factory-applied jackets as follows:
  - 1. Draw jacket tight and smooth.
  - 2. Cover circumferential joints with 3-inch wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
  - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
    - a. For below ambient services, apply vapor-barrier mastic over staples.
  - 4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
  - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.
- Q. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- R. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- S. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

### 3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
  - 1. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
  - 2. Seal jacket to roof flashing with flashing sealant.

- B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated):  
Install insulation continuously through walls and partitions.

### 3.5 MINERAL-FIBER INSULATION INSTALLATION

- A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
  - a. On duct sides with dimensions 16 inches and smaller, no pins required.
  - b. On duct sides with dimensions larger than 16 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
  - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
  - d. Do not overcompress insulation during installation.
  - e. Impale insulation over pins and attach speed washers.
  - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
5. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

- B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
  - a. On duct sides with dimensions 16 inches and smaller, no pins required.
  - b. On duct sides with dimensions larger than 16 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
  - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
  - d. Do not overcompress insulation during installation.
  - e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
5. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

C. Apply insulation to straight pipes and tubes as follows:

1. Secure each layer of preformed pipe insulation to pipe with wire, tape, or bands without deforming insulation materials.
2. Where vapor retarders are indicated, seal longitudinal seams and end joints with vapor-retarder mastic. Apply vapor retarder to ends of insulation at intervals of 15 to 20 feet to form a vapor retarder between pipe insulation segments.
3. For insulation with factory-applied jackets, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets with vapor retarders, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by the insulation material manufacturer and seal with vapor-retarder mastic.

D. Apply insulation to flanges as follows:

1. Apply preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Apply canvas jacket material with manufacturer's recommended adhesive, overlapping seams at least 1 inch, and seal joints with vapor-retarder mastic.

E. Apply insulation to fittings and elbows as follows:

1. Apply pre-molded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When pre-molded insulation elbows and fittings are not available, apply mitered sections of pipe insulation, or glass-fiber blanket insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire, tape or bands.
3. Cover fittings with heavy PVC fitting covers. Overlap PVC covers on pipe insulation jackets at least 1 inch at each end. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.

F. Apply insulation to valves and specialties as follows:

1. Apply pre-molded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When pre-molded insulation sections are not available, apply glass-fiber blanket insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, arrange insulation for access to stainer basket without disturbing insulation.
3. Apply insulation to flanges as specified for flange insulation application.
4. Use preformed heavy PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.

5. For larger sizes where PVC fitting covers are not available, seal insulation with canvas jacket and sealing compound recommended by the insulation material manufacturer.

G. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
  - a. On duct sides with dimensions 16 inches and smaller, no pins required.
  - b. On duct sides with dimensions larger than 16 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
  - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
  - d. Do not overcompress insulation during installation.
  - e. Impale insulation over pins and attach speed washers.
  - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
5. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

### 3.6 PIPING SYSTEM APPLICATIONS

- A. Insulation materials and thicknesses are specified in schedules at the end of this Section.
- B. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials and equipment:
  1. Flexible connectors.
  2. Vibration-control devices.
  3. Air chambers, unions, strainers, check valves, plug valves, and flow regulators.

### 3.7 FIELD-APPLIED JACKET INSTALLATION

- A. Where FSK jackets are indicated, install as follows:
  1. Draw jacket material smooth and tight.
  2. Install lap or joint strips with same material as jacket.
  3. Secure jacket to insulation with manufacturer's recommended adhesive.
  4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
  5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

- B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

- 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

### 3.8 DUCT INSULATION SCHEDULE, GENERAL

- A. Plenums and Ducts Requiring Insulation:

- 1. Indoor supply and outdoor air.
  - 2. Indoor return air.
  - 3. Indoor, exhaust between isolation damper and penetration of building exterior.
  - 4. Outdoor, supply and return.

- B. Items Not Insulated:

- 1. Factory-insulated flexible ducts.
  - 2. Factory-insulated access panels and doors.

### 3.9 INDOOR DUCT INSULATION SCHEDULE

- A. Concealed, Supply Air, round, duct insulation shall be the following:

- 1. Mineral-Fiber Blanket: 2-1/8 inches thick and 0.75-lb/cu. ft. nominal density..

- B. Concealed, Supply Air, rectangular, duct insulation shall be the following:

- 1. Mineral-Fiber Board: 1-1/2 inches thick and 3-lb/cu. ft. nominal density.

- C. Concealed, Neutral Air, round and rectangular, duct insulation shall be the following:

- 1. Mineral-Fiber Blanket: 2-1/8 inches thick and 0.75-lb/cu. ft. nominal density.

- D. Concealed, Return Air, round and rectangular, duct insulation shall be the following:

- 1. Mineral-Fiber Blanket: 2-1/8 inches thick and 0.75-lb/cu. ft. nominal density.

- E. Concealed, Type I, Commercial, Kitchen Hood Exhaust Duct and Plenum Insulation: Fire-rated blanket or board; thickness as required to achieve 2-hour fire rating.

### 3.10 ABOVEGROUND, OUTDOOR DUCT INSULATION SCHEDULE

- A. Insulation materials and thicknesses are identified below. If more than one material is listed for a duct system, selection from materials listed is Contractor's option.

- B. Exposed, rectangular, duct insulation shall be the following:

- 1. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.

### 3.11 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

### 3.12 INTERIOR PIPING INSULATION SCHEDULE

#### A. Chilled water:

1. Operating Temperature: 0 to 100 deg F.
2. Insulation Material: Mineral fiber.
3. Insulation Thickness: Apply the following insulation thicknesses:
  - a. NPS 1-1/4 and Smaller: 1-1/2 inch thickness.
  - b. NPS 1-1/2 through 12: 2 inch thickness.
4. Jacket: PVC, within 10' from the floor level of all mechanical rooms.
5. Vapor Retarder Required: Yes.
6. Finish: None.

#### B. Refrigerant Suction and Liquid Piping:

1. Operating Temperature: -20 to 120 deg F.
2. Insulation Material: Mineral fiber.
3. Insulation Thickness: 1/2 inch thickness.
4. Jacket: PVC, within 10' from the floor level of all mechanical rooms.
5. Vapor Retarder Required: Yes.
6. Finish: None.

#### C. Heating water:

1. Operating Temperature: 0 to 240 deg F.
2. Insulation Material: Mineral fiber.
3. Insulation Thickness: Apply the following insulation thicknesses:
  - a. NPS 1-1/4 and Smaller: 1-1/2 inch thickness.
  - b. NPS 1-1/2 through 12: 2 inch thickness.
4. Jacket: PVC, within 10' from the floor level of all mechanical rooms.
5. Vapor Retarder Required: Yes.
6. Finish: None.

### 3.13 EXTERIOR PIPING INSULATION APPLICATION SCHEDULE

#### A. Refrigerant Suction and Liquid Piping:

1. Operating Temperature: -20 to 120 deg F.
2. Insulation Material: Mineral fiber.
3. Insulation Thickness: 1/2 inch thickness.
4. Jacket: Aluminum-Alloy.
5. Vapor Retarder Required: Yes.
6. Finish: None.

### 3.14 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.



- B. Ducts and Plenums, Exposed.
  - 1. Aluminum, Smooth: 0.024 inch thick.
- C. Piping, Exposed:
  - 1. PVC: 30 mils thick.

END OF SECTION 230700

## **SECTION 230900**

### **INSTRUMENTATION AND CONTROL FOR HVAC**

#### **PART 1 - GENERAL**

##### **1.1 SUMMARY**

- A. This Section includes control equipment for HVAC systems and components.
- B. See Drawings for requirements that relate to this Section.

##### **1.2 SUBMITTALS**

- A. Product Data: For each control device indicated.
- B. Shop Drawings:
  - 1. Schematic flow diagrams.
  - 2. Power, signal, and control wiring diagrams.
  - 3. Details of control panel faces.
  - 4. Damper schedule.
  - 5. Valve schedule.
  - 6. DDC System Hardware: Wiring diagrams, schematic floor plans, and schematic control diagrams.
  - 7. Control System Software: Schematic diagrams, written descriptions, and points list.
- C. Software and firmware operational documentation.
- D. Field quality-control test reports.
- E. Operation and maintenance data.

##### **1.3 QUALITY ASSURANCE**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

##### **1.4 SYSTEM PERFORMANCE**

- A. Comply with the following performance requirements:
  - 1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.
  - 2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.
  - 3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.

4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds
6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
8. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
  - a. Water Temperature: Plus or minus 1 deg F .
  - b. Space Temperature: Plus or minus 0.5 deg F.
  - c. Ducted Air Temperature: Plus or minus 1 deg F.
  - d. Outside Air Temperature: Plus or minus 1 deg F.
  - e. Dew Point Temperature: Plus or minus 1 deg F.
  - f. Relative Humidity: Plus or minus 2 percent.
  - g. Air Pressure (Space): Plus or minus 0.01-inch wg.
  - h. Air Pressure (Ducts): Plus or minus 0.1-inch wg.
9. Countdown Timers: Countdown timers shall be indicated on graphical user interface for any active delay timer used within the control sequence.
10. Sequence Testing Override: A Sequence Testing Override setting shall be provided and accessible to authorized users via password. When enabled, this setting shall cause all input variables to the BAS to be user adjustable. This will allow the Owner to verify and test operation and sequence of equipment. Upon 30 minutes of inactivity, the system shall revert back to normal operational mode.
11. Temperature trending data shall be available for each zone. Data collection rates shall be configurable but shall be initially set to record data once every hour. Sufficient trending data storage shall be provided to allow for a full year's worth of data storage based on initial data sampling rate.
12. User Interface: User interface graphics shall be based on control schematics and plans provided within these bid documents. User interface graphics shall be submitted to the Owner for approval prior to implementation.
13. Control Points: All control points shown on Schematic Control Diagrams Drawings as well as all other control points necessary to provide the sequence of operation shall be incorporated into the graphics. Setpoints and reset schedules shall be adjustable.

#### 1.5 NETWORK ARCHITECTURE

- A. Network switches to be installed in locations approved by Owner.

#### 1.6 COORDINATION

- A. Coordinate location of thermostats and other exposed control sensors with plans and room details before installation.
- B. Coordinate equipment with existing Fire Alarm System to achieve compatibility with equipment that interfaces with that system.
- C. All BacNet IP devices will be issued an owner provided IP address and need to be wired back to the Owner's network switch. No unmanaged network switches are permitted to be connected to the network.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

### 2.2 CONTROL SYSTEM

- A. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems. An operator workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.

### 2.3 DDC EQUIPMENT

- A. General
1. The Building Automation System (BAS) shall consist of a Network Server/Controllers (NSC) and a family of Standalone Digital Control Units (SDCUs). The BAS shall provide control, alarm detection, scheduling, reporting and information management for the entire facility.
  2. BAS user interface shall be web-based and the control system server shall be accessed using a web browser over the control system network and the Owner's local area network.
  3. No JAVA shall be required to access and view the control system.
  4. Systems shall use BACnet communication protocol.
  5. BAS devices with wireless access points will not be permitted.
  6. Shall be compatible with current Windows version or N-1.
  7. All network enabled BAS devices must be IPv4 capable.
  8. BAS devices must use wired media in the form of CAT5 or fiber to connect to the Owner's network. No wireless connectivity is permissible.
  9. The system shall be designed with a top-level 10/100bT Ethernet network, using the BACnet/IP protocol.
- B. Acceptable Manufacturers:
1. Schneider Electric
  2. Siemens
  3. Johnson Controls
  4. Honeywell
- C. A sub-network of SDCUs using the BACnet IP protocol shall connect the local, stand-alone controllers with Ethernet-level Network Server Controllers/IP Routers. All SDCU field controllers shall reside on their own private IP based network and shall communicate back to the NSC. SDCUs shall not require Owner provided IP addresses.

D. Application Software:

1. System security for each operator via software password and access levels.
2. Automatic system diagnostics; monitor system and report failures.
3. Database creation and support.
4. Automatic and manual database save and restore.
5. Dynamic color graphic displays with up to 10 screen displays at once.
6. Custom graphics generation and graphics library of HVAC equipment and symbols.
7. Alarm processing, messages, printing, and reactions.
8. Trend logs retrievable in spreadsheets and database programs.
9. Alarm and event processing.
10. Object and property status and control.
11. Automatic restart of field equipment on restoration of power.
12. Data collection, report printing, and logs. Include standard reports for the following:
  - a. Current values of all objects.
  - b. Current alarm summary.
  - c. Override summary
  - d. Disabled objects.
  - e. Alarm lockout objects.
  - f. Logs.
13. Custom report development.
14. Workstation application editors for controllers and schedules.
15. Maintenance management.

E. Custom Application Software:

1. English language oriented.
2. Full-screen character editor/programming environment.
3. Allow development of independently executing program modules with debugging/simulation capability.
4. Support conditional statements.
5. Support floating-point arithmetic with mathematic functions.
6. Contains predefined time variables.

2.4 UNITARY CONTROLLERS

- A. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.
1. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 72>-hour battery backup.
  2. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform automatic system diagnostics; monitor system and report failures.
  3. Enclosure: Dustproof rated for operation at 32 to 120 deg F.

## 2.5 ELECTRONIC SENSORS

- A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.
- B. Thermistor Temperature Sensors and Transmitters:
  - 1. Manufacturers:
    - a. BEC Controls Corporation.
    - b. Ebtron, Inc.
    - c. Heat-Timer Corporation.
    - d. I.T.M. Instruments Inc.
    - e. MAMAC Systems, Inc.
    - f. RDF Corporation.
  - 2. Accuracy: Plus or minus 0.5 deg F at calibration point.
  - 3. Wire: Twisted, shielded-pair cable.
  - 4. Insertion Elements in Ducts: Single point, 8 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft..
  - 5. Averaging Elements in Ducts: 36 inches long, flexible; use where prone to temperature stratification or where ducts are larger than 10 sq. ft..
  - 6. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches.
- C. RTDs and Transmitters:
  - 1. Manufacturers:
    - a. BEC Controls Corporation.
    - b. Ebtron, Inc.
    - c. Heat-Timer Corporation.
    - d. I.T.M. Instruments Inc.
    - e. MAMAC Systems, Inc.
    - f. RDF Corporation.
  - 2. Accuracy: Plus or minus 0.2 percent at calibration point.
  - 3. Wire: Twisted, shielded-pair cable.
  - 4. Insertion Elements in Ducts: Single point, 8 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft..
  - 5. Averaging Elements in Ducts: 24 inches long, rigid; use where prone to temperature stratification or where ducts are larger than 9 sq. ft.; length as required.
  - 6. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches.
- D. Pressure Transmitters/Transducers:
  - 1. Manufacturers:
    - a. BEC Controls Corporation.
    - b. General Eastern Instruments.
    - c. MAMAC Systems, Inc.
    - d. ROTRONIC Instrument Corp.
    - e. TCS/Basys Controls.
    - f. Vaisala.

2. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.
  - a. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
  - b. Output: 4 to 20 mA.
  - c. Building Static-Pressure Range: 0- to 0.25-inch wg.
  - d. Duct Static-Pressure Range: 0- to 5-inch wg.
3. Water Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure; linear output 4 to 20 mA.
4. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure and tested to 300-psig; linear output 4 to 20 mA.
5. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.
6. Pressure Transmitters: Direct acting for gas or liquid service; range suitable for system; linear output 4 to 20 mA.

## 2.6 STATUS SENSORS

- A. Status Inputs for Fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch wg.
- B. Status Inputs for Pumps: Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range of 8 to 60 psig, piped across pump.
- C. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.
- D. Voltage Transmitter (100- to 600-V ac): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.
- E. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.
- F. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.

## 2.7 ACTUATORS

- A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
  1. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
  2. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
  3. Spring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running and breakaway torque of 150 in. x lbf.

4. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
  5. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.
- B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
1. Manufacturers:
    - a. Belimo Aircontrols (USA), Inc.
    - b. KMC Controls.
    - c. Siemens.
  2. Valves: Size for torque required for valve close off at maximum pump differential pressure.
  3. Dampers: Size for running torque calculated as follows:
    - a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
    - b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
    - c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft. of damper.
    - d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.
    - e. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.
    - f. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.
  4. Coupling: V-bolt and V-shaped, toothed cradle.
  5. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
  6. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
  7. Power Requirements (Two-Position Spring Return): 120-V ac.
  8. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
  9. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
  10. Temperature Rating: Minus 22 to plus 122 deg F.
  11. Run Time: 12 seconds open, 5 seconds closed.

## 2.8 CONTROL VALVES

- A. Manufacturers:
1. Danfoss Inc.; Air Conditioning & Refrigeration Div.
  2. Erie Controls.
  3. Hayward Industrial Products, Inc.
  4. Magnatrol Valve Corporation.
  5. Neles-Jamesbury.
  6. Parker Hannifin Corporation; Skinner Valve Division.
  7. Pneuline Controls.
  8. Sauter Controls Corporation.
- B. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.



- C. Hydronic system globe valves shall have the following characteristics:
1. NPS 2 and Smaller: Class 125 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure.
  2. NPS 2-1/2 and Larger: Class 125 iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.
  3. Internal Construction: Replaceable plugs and stainless-steel or brass seats.
    - a. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom.
    - b. Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom.
  4. Sizing: 3-psig maximum pressure drop at design flow rate or the following:
    - a. Two Position: Line size.
    - b. Two-Way Modulating: Either the value specified above or twice the load pressure drop, whichever is more.
    - c. Three-Way Modulating: Twice the load pressure drop, but not more than value specified above.
  5. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.
  6. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system (pump) head for two-way valves and 100 percent of pressure differential across valve or 100 percent of total system (pump) head.
- D. Butterfly Valves: 200-psig, 150-psig maximum pressure differential, ASTM A 126 cast-iron or ASTM A 536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals.
1. Body Style: Lug.
  2. Disc Type: Nickel-plated ductile iron.
  3. Sizing: 1-psig maximum pressure drop at design flow rate.
- E. Terminal Unit Control Valves: Bronze body, bronze trim, two or three ports as indicated, replaceable plugs and seats, and union and threaded ends.
1. Rating: Class 125 for service at 125 psig and 250 deg F operating conditions.
  2. Sizing: 3-psig maximum pressure drop at design flow rate, to close against pump shutoff head.
  3. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.
- F. Self-Contained Control Valves: Bronze body, bronze trim, two or three ports as indicated, replaceable plugs and seats, and union and threaded ends.
1. Rating: Class 125 for service at 125 psig and 250 deg F operating conditions.
  2. Thermostatic Operator: Liquid-filled remote sensor with remote adjustable dial.

## 2.9 DAMPERS

### A. Manufacturers:

1. Air Balance Inc.
2. Don Park Inc.; Autodamp Div.
3. TAMCO (T. A. Morrison & Co. Inc.).
4. United Enertech Corp.
5. Vent Products Company, Inc.

### B. Dampers: AMCA-rated, opposed-blade design; 0.108-inch- minimum thick, galvanized-steel or 0.125-inch- minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-inch- thick galvanized steel with maximum blade width of 8 inches and length of 48 inches.

1. Secure blades to 1/2-inch- diameter, zinc-plated axles using zinc-plated hardware, with oil-impregnated sintered bronze or nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
2. Operating Temperature Range: From minus 40 to plus 200 deg F.
3. Edge Seals, Standard Pressure Applications: Closed-cell neoprene.
4. Edge Seals, Low-Leakage Applications: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for leakage at less than 10 cfm per sq. ft. of damper area, at differential pressure of 4-inch wg when damper is held by torque of 50 in. x lbf; when tested according to AMCA 500D.

## 2.10 FLOW METERS

- A. Electronics Enclosure: Weathertight NEMA 4 aluminum enclosure.
- B. Sensing Method: Dual turbine electronic impedance sensing (non-magnetic and non-photoelectric) and frequency averaging circuitry.
- C. Flow Range: 0.1ft/s to 20 ft/s.
- D. Liquid Temperature Range: 15°F to 180°F.
- E. Ambient Temperature Range: -5°F to 160°F.
- F. Wetted Metal Components: Electroless nichel plated brass.
- G. Accuracy: Plus or minus 2 percent of reading from 0.4ft/s to 20ft/s.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches above the floor.

- B. Install locking guards on thermostats in the following locations:
  - 1. Entrances.
  - 2. Corridors.
- C. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

### 3.2 ELECTRICAL WIRING AND CONNECTION INSTALLATION

- A. Connect manual-reset limit controls independent of manual-control switch positions.
- B. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

### 3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
  - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
  - 2. Test and adjust controls and safeties.
  - 3. Test calibration of controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
  - 4. Test each point through its full operating range to verify that safety and operating control set points are as required.
  - 5. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
  - 6. Test each system for compliance with sequence of operation.
  - 7. Test software and hardware interlocks.
- C. DDC Verification:
  - 1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
  - 2. Check instruments for proper location and accessibility.
  - 3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
  - 4. Check instrument tubing for proper fittings, slope, material, and support.
  - 5. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
  - 6. Check temperature instruments and material and length of sensing elements.
  - 7. Check control valves. Verify that they are in correct direction.
  - 8. Check DDC system as follows:
    - a. Verify that DDC controller power supply is from emergency power supply, if applicable.
    - b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
    - c. Verify that spare I/O capacity has been provided.

- d. Verify that DDC controllers are protected from power supply surges.
- D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

### 3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls.
  - 1. The training shall be for a minimum of four hours.
  - 2. The Owner shall provide four maintenance personnel to be trained by the factory-authorized service representative.

END OF SECTION 230900

## **SECTION 232113 HYDRONIC PIPING**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:
  - 1. Hot-water heating piping.
  - 2. Chilled-water piping.
  - 3. Makeup-water piping.
  - 4. Condensate-drain piping.
  - 5. Blowdown-drain piping.
  - 6. Air-vent piping.
  - 7. Safety-valve-inlet and -outlet piping.

#### **1.2 SUBMITTALS**

- A. Product Data: For each type of the following:
  - 1. Pressure-seal fittings.
  - 2. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
  - 3. Air control devices.
  - 4. Chemical treatment.
  - 5. Hydronic specialties.
- B. Operation and maintenance data.

#### **1.3 PERFORMANCE REQUIREMENTS**

- A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:
  - 1. Hot-Water Heating Piping: 125 psig at 200 deg F Insert temperature.
  - 2. Chilled-Water Piping: 125 psig at 200 deg F.
  - 3. Makeup-Water Piping: 80 psig Insert pressure at 150 deg F.
  - 4. Condensate-Drain Piping: 150 deg F Insert temperature.
  - 5. Blowdown-Drain Piping: 200 deg F Insert temperature.
  - 6. Air-Vent Piping: 200 deg F Insert temperature.
  - 7. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

#### **1.4 QUALITY ASSURANCE**

- A. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME

label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

## **PART 2 - PRODUCTS**

### **2.1 COPPER TUBE AND FITTINGS**

- A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.
- B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.
- C. DWV Copper Tubing: ASTM B 306, Type DWV.
- D. Wrought-Copper Fittings: ASME B16.22.
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
    - a. Anvil International, Inc.
    - b. S. P. Fittings; a division of Star Pipe Products.
    - c. Victaulic Company of America.
  - 4. Grooved-End Copper Fittings: ASTM B 75, copper tube or ASTM B 584, bronze casting.
  - 5. Grooved-End-Tube Couplings: Rigid pattern, unless otherwise indicated; gasketed fitting. Ductile-iron housing with keys matching pipe and fitting grooves, prelubricated EPDM gasket rated for minimum 230 deg F for use with housing, and steel bolts and nuts.
- E. Wrought-Copper Unions: ASME B16.22.

### **2.2 STEEL PIPE AND FITTINGS**

- A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; type, grade, and wall thickness as indicated in Part 3 "Piping Applications" Article.
- B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in Part 3 "Piping Applications" Article.
- C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in Part 3 "Piping Applications" Article.
- D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 "Piping Applications" Article.
- E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in Part 3 "Piping Applications" Article.

- F. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
1. Material Group: 1.1.
  2. End Connections: Butt welding.
  3. Facings: Raised face.
- G. Grooved Mechanical-Joint Fittings and Couplings:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
    - a. Anvil International, Inc.
    - b. Central Sprinkler Company; a division of Tyco Fire & Building Products.
    - c. National Fittings, Inc.
    - d. S. P. Fittings; a division of Star Pipe Products.
    - e. Victaulic Company of America.
  4. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47/A 47M, Grade 32510 malleable iron; ASTM A 53/A 53M, Type F, E, or S, Grade B fabricated steel; or ASTM A 106, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
  5. Couplings: Ductile- or malleable-iron housing and synthetic rubber gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

## 2.3 JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
    - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
    - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

F. Solvent Cements for Joining Plastic Piping:

1. CPVC Piping: ASTM F 493.
2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

G. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.4 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper-alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Capitol Manufacturing Company.
  - b. Central Plastics Company.
  - c. Hart Industries International, Inc.
  - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
  - e. Zurn Plumbing Products Group; AquaSpec Commercial Products Division.
3. Factory-fabricated union assembly, for 250-psig minimum working pressure at 180 deg F.

D. Dielectric Couplings:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Calpico, Inc.
  - b. Lochinvar Corporation.
3. Galvanized-steel coupling with inert and noncorrosive thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

2.5 VALVES

A. Bronze, Calibrated-Orifice, Balancing Valves:

1. Manufacturers: Subject to compliance with requirements.
2. Body: Bronze, ball or plug type with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.



4. Plug: Resin.
5. Seat: PTFE.
6. End Connections: Threaded or socket.
7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
8. Handle Style: Lever, with memory stop to retain set position.
9. CWP Rating: Minimum 125 psig.
10. Maximum Operating Temperature: 250 deg F.

B. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:

1. Manufacturers: Subject to compliance with requirements.
2. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Stem Seals: EPDM O-rings.
5. Disc: Glass and carbon-filled PTFE.
6. Seat: PTFE.
7. End Connections: Flanged or grooved.
8. Pressure Gage Connections: Integral seals for portable differential pressure meter.
9. Handle Style: Lever, with memory stop to retain set position.
10. CWP Rating: Minimum 125 psig.
11. Maximum Operating Temperature: 250 deg F.

C. Automatic Flow-Control Valves:

1. Manufacturers: Subject to compliance with requirements.
2. Body: Brass or ferrous metal.
3. Piston and Spring Assembly: Stainless steel, tamper proof, self cleaning, and removable.
4. Combination Assemblies: Include bronze or brass-alloy ball valve.
5. Identification Tag: Marked with zone identification, valve number, and flow rate.
6. Size: Same as pipe in which installed.
7. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.
8. Minimum CWP Rating: 175 psig.
9. Maximum Operating Temperature: 200 deg F.

## 2.6 AIR CONTROL DEVICES

A. Manufacturers: Subject to compliance with requirements.

B. Manual Air Vents:

1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Screwdriver or thumbscrew.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/8.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 225 deg F.

C. Expansion Tanks:

1. Tank: Welded steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature, with taps in bottom of tank for tank fitting and taps in end of tank

for gage glass. Tanks shall be factory tested with taps fabricated and labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

2. Air-Control Tank Fitting: Cast-iron body, copper-plated tube, brass vent tube plug, and stainless-steel ball check, 100-gal. unit only; sized for compression-tank diameter. Provide tank fittings for 125-psig working pressure and 250 deg F maximum operating temperature.
3. Tank Drain Fitting: Brass body, nonferrous internal parts; 125-psig working pressure and 240 deg F maximum operating temperature; constructed to admit air to compression tank, drain water, and close off system.
4. Gage Glass: Full height with dual manual shutoff valves, 3/4-inch- diameter gage glass, and slotted-metal glass guard.

D. In-Line Air Separators:

1. Tank: One-piece cast iron with an integral weir constructed to decelerate system flow to maximize air separation.
2. Maximum Working Pressure: Up to 175 psig.
3. Maximum Operating Temperature: Up to 300 deg F.

2.7 CHEMICAL TREATMENT

A. Bypass Chemical Feeder: Welded steel construction; 125-psig working pressure; 5-gal. capacity; with fill funnel and inlet, outlet, and drain valves.

1. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.

2.8 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

B. Stainless-Steel Bellow, Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inch misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250 deg F.

C. Test Plugs

1. Manufacturers:
  - a. Winters.
  - b. Petersen.

- c. Watts.
- 2. 1/4 inch NPT or 1/2 inch NPT stainless steel fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with:
  - a. Neoprene core for temperatures up to 200 degrees F.
  - b. Norel core for temperatures up to 350 degrees F.
  - c. Viton core for temperatures up to 400 degrees F.
- 3. Test Kit:
  - a. Carrying case, internally padded and fitted containing:
    - 1) One 3-1/2 inch diameter pressure gages.
    - 2) One gage adapters with 1/8 inch probes.
    - 3) Two 1-1/2 inch dial thermometers.
- D. Flexible Connectors
  - 1. Manufacturers:
    - a. Hosecraft.
    - b. Ferguson Enterprises, Inc.
    - c. Zoro.
  - 2. Corrugated stainless steel hose with single layer of stainless steel exterior braiding, minimum 9 inches long with copper tube ends; for maximum working pressure 500 psig.
- E. Air Vents
  - 1. Manufacturers:
    - a. Watts.
    - b. Bell and Gossett.
    - c. Honeywell.
  - 2. Manual Type: Short vertical sections of 2 inch diameter pipe to form air chamber, with 1/8 inch brass needle valve at top of chamber.
  - 3. Float Type:
    - a. Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.
  - 4. Washer Type:
    - a. Brass with hydroscopic fiber discs, vent ports, adjustable cap for manual shut-off, and integral spring loaded ball check valve.
- F. Strainers
  - 1. Manufacturers:
    - a. Watts.

- b. Bell and Gossett.
  - c. Honeywell.
- 2. Size 2 inch and Smaller:
  - a. Screwed brass or iron body for 175 psig working pressure, Y pattern with 1/32 inch stainless steel perforated screen.
- 3. Size 2-1/2 inch to 4 inch:
  - a. Flanged iron body for 175 psig working pressure, Y pattern with 3/64 inch stainless steel perforated screen.
- 4. Size 5 inch and Larger:
  - a. Flanged iron body for 175 psig working pressure, basket pattern with 1/8 inch stainless steel perforated screen.

G. Relief Valves

- 1. Manufacturers:
  - a. Watts.
  - b. Bell and Gossett.
  - c. Zoro.
- 2. Bronze body, Teflon seat, stainless steel stem and springs, automatic, direct pressure actuated capacities ASME certified and labeled.

**PART 3 - EXECUTION**

3.1 PIPING APPLICATIONS

- A. Hot-water heating piping, aboveground, NPS 2 and smaller, shall be any of the following:
  - 1. Schedule 40 steel pipe; Class 125, cast-iron fittings; cast-iron flanges and flange fittings; and threaded joints.
- B. Hot-water heating piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:
  - 1. Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.
- C. Chilled-water piping, aboveground, NPS 2 and smaller, shall be any of the following:
  - 1. Schedule 40 steel pipe; Class 125, cast-iron fittings; cast-iron flanges and flange fittings; and threaded joints.
- D. Chilled-water piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:
  - 1. Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.

- E. Makeup-water piping installed aboveground shall be the following:
  - 1. Type L, drawn-temper copper tubing, wrought-copper fittings, and pressure-seal or brazed joints.
- F. Condensate-Drain Piping: Schedule 40 PVC plastic pipe and fittings and solvent-welded joints.
- G. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.
- H. Air-Vent Piping:
  - 1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.
  - 2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.
- I. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.

### 3.2 VALVE APPLICATIONS

- A. Install shutoff-duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.
- B. Install throttling-duty valves at each branch connection to return main.
- C. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.
- D. Install check valves at each pump discharge and elsewhere as required to control flow direction.
- E. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; and pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.
- F. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

### 3.3 PIPING INSTALLATIONS

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Locate test plugs adjacent to thermometers and thermometer sockets.
- J. Where large air quantities accumulate, provide enlarged air collection standpipes.
- K. Install manual air vents at system high points.
- L. For automatic air vents in ceiling spaces or other concealed locations, install vent tubing to nearest drain.
- M. Provide relief valves on pressure tanks, low-pressure side of reducing valves, heat exchangers, and expansion tanks.
- N. Select system relief valve capacity greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.
- O. Pipe relief valve outlet to nearest floor drain.
- P. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.
- Q. Install piping to allow application of insulation.
- R. Select system components with pressure rating equal to or greater than system operating pressure.
- S. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- T. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- U. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
- V. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- W. Install branch connections to mains using mechanically formed tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
- X. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- Y. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

- Z. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

### 3.4 HANGERS AND SUPPORTS

- A. Install the following pipe attachments:
1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
  2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
  3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
  4. Spring hangers to support vertical runs.
- B. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
1. NPS 3/4: Maximum span, 7 feet; minimum rod size, 1/4 inch.
  2. NPS 1: Maximum span, 7 feet; minimum rod size, 1/4 inch.
  3. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
  4. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
  5. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 3/8 inch.
  6. NPS 3: Maximum span, 12 feet; minimum rod size, 3/8 inch.
  7. NPS 4: Maximum span, 14 feet; minimum rod size, 1/2 inch.
- C. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

### 3.5 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
  2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

### 3.6 HYDRONIC SPECIALTIES INSTALLATION

- A. Install gage taps in piping.
- B. Install pressure gages with pulsation dampers. Provide needle valve or ball valve to isolate each gage. Extend nipples to allow clearance from insulation.
- C. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inches for installation of thermometer sockets. Allow clearance from insulation.
- D. Install thermometer sockets adjacent to controls systems thermostat, transmitter, or sensor sockets.
- E. Coil and conceal excess capillary on remote element instruments.
- F. Provide instruments with scale ranges selected according to service with largest appropriate scale.
- G. Install gages and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
- H. Adjust gages and thermometers to final angle, clean windows and lenses, and calibrate to zero.
- I. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.
- J. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.
- K. Install in-line air separators in pump suction. Install drain valve on air separators NPS 2 and larger.
- L. Install bypass chemical feeders in each hydronic system where indicated, in upright position with top of funnel not more than 48 inches above the floor. Install feeder in minimum NPS 3/4 bypass line, from main with full-size, full-port, ball valve in the main between bypass connections. Install NPS 3/4 pipe from chemical feeder drain, to nearest equipment drain and include a full-size, full-port, ball valve.
- M. Install expansion tanks above the air separator. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.
  - 1. Install tank fittings that are shipped loose.
  - 2. Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, fittings, plus tank full of water. Do not overload building components and structural members.

### 3.7 TERMINAL EQUIPMENT CONNECTIONS

- A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.
- B. Install control valves in accessible locations close to connected equipment.



- C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

### 3.8 CHEMICAL TREATMENT

- A. Fill system with fresh water and add liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products from piping. Circulate solution for a minimum of 24 hours, drain, clean strainer screens, and refill with fresh water.
- B. Add initial chemical treatment and maintain water quality in ranges noted above for the first year of operation.

### 3.9 FIELD QUALITY CONTROL

- A. Prepare hydronic piping according to ASME B31.9 and as follows:
  - 1. Leave joints, including welds, uninsulated and exposed for examination during test.
  - 2. Do not install hydronic pressure gauges until after systems are pressure tested.
  - 3. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
  - 4. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
  - 5. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
  - 6. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
- B. Perform the following tests on hydronic piping:
  - 1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
  - 2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
  - 3. Isolate expansion tanks and determine that hydronic system is full of water.
  - 4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
  - 5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components and repeat hydrostatic test until there are no leaks.
  - 6. Prepare written report of testing.
- C. Perform the following before operating the system:
  - 1. Open manual valves fully.
  - 2. Inspect pumps for proper rotation.
  - 3. Set makeup pressure-reducing valves for required system pressure.

4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

END OF SECTION 232113

## **SECTION 232123 HYDRONIC PUMPS**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. This Section includes the following:
  - 1. Close-coupled, end-suction centrifugal pumps.

#### **1.2 SUBMITTALS**

- A. Product Data: Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.
- B. Operation and maintenance data.

#### **1.3 QUALITY ASSURANCE**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

### **PART 2 - PRODUCTS**

#### **2.1 MANUFACTURERS**

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

#### **2.2 CLOSE-COUPLED, END-SUCTION CENTRIFUGAL PUMPS**

- A. Manufacturers:
  - 1. Armstrong Pumps Inc.
  - 2. Aurora Pump; Division of Pentair Pump Group.
  - 3. Bell & Gossett; Div. of ITT Industries.
  - 4. Patterson Pump Co.; a Subsidiary of The Gorman-Rupp Co.
  - 5. Peerless Pump; a Member of the Sterling Fluid Systems Group.

- B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally. Rate pump for 175-psig minimum working pressure and a continuous water temperature of 225 deg F.
- C. Pump Construction:
  - 1. Casing: Radially split, cast iron, with replaceable bronze wear rings, drain plug at bottom and air vent at top of volute, threaded gage tappings at inlet and outlet, and flanged connections.
  - 2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
  - 3. Pump Shaft: Stainless steel.
  - 4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and EPT bellows and gasket. Include water slinger on shaft between motor and seal.
  - 5. Pump Bearings: Permanently lubricated ball bearings.
  - 6. Motor: Single speed, with permanently lubricated ball bearings, unless otherwise indicated; rigidly mounted to pump casing with integral pump support. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

## 2.3 PUMP SPECIALTY FITTINGS

- A. Suction Diffuser: Angle pattern, 300-psig pressure rating, cast-iron body and end cap, pump-inlet fitting; with bronze startup and bronze or stainless-steel permanent strainers; bronze or stainless-steel straightening vanes; drain plug; and factory-fabricated support.
- B. Triple-Duty Valve: Angle or straight pattern, 300-psig pressure rating, cast-iron body, pump-discharge fitting; with drain plug and bronze-fitted shutoff, balancing, and check valve features. Brass gage ports with integral check valve, and orifice for flow measurement.

## PART 3 - EXECUTION

### 3.1 PUMP INSTALLATION

- A. Comply with HI 1.4.
- B. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.
- C. Install one pressure gage for each pump, locate taps before strainers and on suction and discharge of pump; pipe to gage.
- D. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.
- E. Install continuous-thread hanger rods and spring hangers with vertical-limit stop of sufficient size to support pump weight. Fabricate brackets or supports as required.

- F. Suspend vertically mounted, in-line centrifugal pumps independent of piping. Install pumps with motor and pump shafts vertical. Use continuous-thread hanger rods and spring hangers with vertical-limit stop of sufficient size to support pump weight.
- G. Set base-mounted pumps on concrete foundation. Disconnect coupling before setting. Do not reconnect couplings until alignment procedure is complete.
  - 1. Support pump baseplate on rectangular metal blocks and shims, or on metal wedges with small taper, at points near foundation bolts to provide a gap of 3/4 to 1-1/2 inches between pump base and foundation for grouting.
  - 2. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and suction and discharge flanges of pump to verify that they are level and plumb.

### 3.2 ALIGNMENT

- A. Align pump and motor shafts and piping connections after setting on foundation, grout has been set and foundation bolts have been tightened, and piping connections have been made.
- B. Comply with pump and coupling manufacturers' written instructions.
- C. Adjust pump and motor shafts for angular and offset alignment by methods specified in HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation."
- D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

### 3.3 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.
- D. Provide pump suction fitting on suction side of base mounted centrifugal pumps. Remove temporary strainers after cleaning systems.
- E. Provide combination pump discharge valve on discharge side of base mounted centrifugal pumps.
- F. Support pump fittings with floor mounted pipe and flange supports.
- G. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
- H. Install check valve and throttling valve on discharge side of pumps.
- I. Install suction diffuser and shutoff valve on suction side of pumps.
- J. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.

- K. Install pressure gages on pump suction and discharge, at integral pressure-gage tapping, or install single gage with multiple input selector valve.

END OF SECTION 232123

## **SECTION 233113**

### **METAL DUCTS**

#### **PART 1 - GENERAL**

##### **1.1 SUMMARY**

- A. Section Includes:
  - 1. Single-wall rectangular ducts and fittings.
  - 2. Single-wall round ducts and fittings.
  - 3. Sheet metal materials.
  - 4. Sealants and gaskets.
  - 5. Hangers and supports.

##### **1.2 QUALITY ASSURANCE**

- A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 – “Systems and Equipment” and Section 7 – “Construction and System Start-up.”
- B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 – “HVAC System Construction and Insulation.”

#### **PART 2 - PRODUCTS**

##### **2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS**

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

## 2.2 SINGLE-WALL ROUND DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
  - 1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
  - 1. Fabricate round ducts larger than 90 in diameter with butt-welded longitudinal seams.
- D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

## 2.3 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
  - 1. Galvanized Coating Designation: G90.

## 2.4 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Two-Part Tape Sealing System:
  - 1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
  - 2. Tape Width: 4 inches.
  - 3. Sealant: Modified styrene acrylic.
  - 4. Water resistant.
  - 5. Mold and mildew resistant.



6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.

## 2.5 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."
- C. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- D. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- E. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- F. Trapeze and Riser Supports:
  1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

## PART 3 - EXECUTION

### 3.1 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install round ducts in maximum practical lengths.
- D. Install ducts with fewest possible joints.
- E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

- H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
- K. Protect duct interiors from moisture, construction debris and dust, and other foreign materials.

### 3.2 SEAM AND JOINT SEALING

- A. Seal duct seams and joints for duct static-pressure and leakage classes specified in "Performance Requirements" Article, according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 1-2, "Standard Duct Sealing Requirements," unless otherwise indicated.

### 3.3 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
  - 1. Where practical, install concrete inserts before placing concrete.
  - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
  - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
  - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
  - 5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at maximum intervals of 16 feet.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

### 3.4 PAINTING

- A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer.

### 3.5 DUCT SCHEDULE

- A. Fabricate ducts with galvanized sheet steel.

- B. Elbow Configuration:

- 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."

- a. Velocity 1000 fpm or Lower:

- 1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.

- b. Velocity 1000 to 1500 fpm:

- 1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
      - 2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
      - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."

- c. Velocity 1500 fpm or Higher:

- 1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
      - 2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
      - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."

- 2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3, "Round Duct Elbows."

- a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

- 1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
      - 2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
      - 3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.

- b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.

- c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

- C. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-6, "Branch Connections."
  - a. Rectangular Main to Rectangular Branch: 45-degree entry.
  - b. Rectangular Main to Round Branch: High efficiency takeoff with gasket.
2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals."
  - a. Velocity 1000 fpm or Lower: 90-degree tap.
  - b. Velocity 1000 fpm or Higher: 45-degree lateral.

END OF SECTION 233113

**SECTION 233300**  
**AIR DUCT ACCESSORIES**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
  - 1. Manual volume dampers.
  - 2. Control dampers.
  - 3. Flange connectors.
  - 4. Turning vanes.
  - 5. Duct-mounted access doors.
  - 6. Flexible connectors.
  - 7. Flexible ducts.
  - 8. Duct accessory hardware.

**1.2 SUBMITTALS**

- A. Product Data: For each type of product indicated.

**1.3 QUALITY ASSURANCE**

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with AMCA 500-D testing for damper rating.

**PART 2 - PRODUCTS**

**2.1 MATERIALS**

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
  - 1. Galvanized Coating Designation: G90.
  - 2. Exposed-Surface Finish: Mill phosphatized.
- C. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts.
- D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

## 2.2 MANUAL VOLUME DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Air Balance Inc.; a division of Mestek, Inc.
2. American Warming and Ventilating; a division of Mestek, Inc.
3. Flexmaster U.S.A., Inc.
4. McGill AirFlow LLC.
5. METALAIRE, Inc.
6. Nailor Industries Inc.
7. Pottorff; a division of PCI Industries, Inc.
8. Ruskin Company.
9. Trox USA Inc.
10. Vent Products Company, Inc.

B. Standard, Steel, Manual Volume Dampers:

1. Standard leakage rating.
2. Suitable for horizontal or vertical applications.
3. Frames:
  - a. Hat-shaped, galvanized steel channels, 0.064-inch minimum thickness.
  - b. Mitered and welded corners.
  - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
4. Blades:
  - a. Multiple or single blade.
  - b. Parallel-blade design.
  - c. Stiffen damper blades for stability.
  - d. Galvanized-steel, 0.064 inch thick.
5. Blade Axles: Galvanized steel.
6. Bearings:
  - a. Synthetic.
  - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
7. Tie Bars and Brackets: Galvanized steel.

C. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

## 2.3 CONTROL DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American Warming and Ventilating; a division of Mestek, Inc.
  2. Greenheck Fan Corporation.
  3. Nailor Industries Inc.
  4. NCA Manufacturing, Inc.
  5. Ruskin Company.
  6. Vent Products Company, Inc.
- B. Low-leakage rating and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
- C. Frames:
1. Hat shaped.
  2. Galvanized-steel channels, 0.064 inch thick.
  3. Mitered and welded corners.
- D. Blades:
1. Multiple blade with maximum blade width of 8 inches.
  2. Opposed-blade design.
  3. Galvanized steel.
  4. 0.064 inch thick.
  5. Blade Edging: Closed-cell neoprene edging.
  6. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.
- E. Blade Axles: 1/2-inch-diameter; galvanized steel blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.
1. Operating Temperature Range: From minus 40 to plus 200 deg F.
- F. Bearings:
1. Synthetic.
  2. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
  3. Thrust bearings at each end of every blade.
- 2.4 FLANGE CONNECTORS
- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ductmate Industries, Inc.
  2. Nexus PDQ; Division of Shilco Holdings Inc.
  3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
- C. Material: Galvanized steel.
- D. Gage and Shape: Match connecting ductwork.

## 2.5 TURNING VANES

- A. Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
  - 1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.
- B. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-3, "Vanes and Vane Runners," and 2-4, "Vane Support in Elbows."
- C. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

## 2.6 DUCT-MOUNTED ACCESS DOORS

- A. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - Round Duct."
  - 1. Door:
    - a. Double wall, rectangular.
    - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
    - c. Vision panel.
    - d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
    - e. Fabricate doors airtight and suitable for duct pressure class.
  - 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
  - 3. Number of Hinges and Locks:
    - a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
    - b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
    - c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches.
    - d. Access Doors Larger Than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.

## 2.7 FLEXIBLE CONNECTORS

- A. Materials: Flame-retardant or noncombustible fabrics.
- B. Coatings and Adhesives: Comply with UL 181, Class 1.
- C. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to 2 strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.
- D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
  - 1. Minimum Weight: 26 oz./sq. yd.
  - 2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
  - 3. Service Temperature: Minus 40 to plus 200 deg F.



## 2.8 FLEXIBLE DUCTS

- A. Insulated, Flexible Duct: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.
  - 1. Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.
  - 2. Maximum Air Velocity: 4000 fpm.
  - 3. Temperature Range: Minus 20 to plus 175 deg F.
- B. Flexible Duct Connectors:
  - 1. Clamps: Nylon strap in sizes 3 through 18 inches, to suit duct size.

## 2.9 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
- E. Set dampers to fully open position before testing, adjusting, and balancing.
- F. Install test holes at fan inlets and outlets and elsewhere as indicated.
- G. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
  - 1. At maximum 50-foot spacing.
  - 2. Upstream of turning vanes.
  - 3. Elsewhere as indicated.

- H. Install access doors with swing against duct static pressure.
- I. Access Door Sizes: (install the largest size below based on the ductwork size)
  - 1. Hand Access: 6 by 10 inches.
  - 2. Head and Hand Access: 12 by 12 inches.
  - 3. Head and Shoulders Access: 18 by 18 inches.
- J. Install flexible connectors to connect ducts to equipment with an airflow over 2000 cfm.
- K. Connect diffusers to low-pressure ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.
- L. Install duct test holes where required for testing and balancing purposes.

END OF SECTION 233300

## **SECTION 233416 CENTRIFUGAL HVAC FANS**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. This Section includes the following:
  - 1. Backward-inclined centrifugal fans.

#### **1.2 SUBMITTALS**

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated.
- B. Operation and maintenance data.

#### **1.3 QUALITY ASSURANCE**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.
- C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA 1.

### **PART 2 - PRODUCTS**

#### **2.1 BACKWARD-INCLINED CENTRIFUGAL FANS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. ABB Fan Group North America.
  - 2. Acme Engineering & Mfg. Corp.
  - 3. Aerovent; a Twin City Fan Company.
  - 4. Airmaster Fan Co.
  - 5. Ammerman; General Resource Corp.
  - 6. Bayley Fans; a division of Lau Industries, Inc.
  - 7. Captiveaire Systems.
  - 8. Carrier Corporation.
  - 9. Central Blower Company.
  - 10. Chicago Blower Corporation.
  - 11. Cincinnati Fan.
  - 12. CML Northern Blower Inc.

13. Greenheck Fan Corporation.
  14. Howden Fan Co.
  15. Industrial Air; a division of Lau Industries, Inc.
  16. Loren Cook Company.
  17. Madison Manufacturing.
  18. New Philadelphia Fan Co.
  19. New York Blower Company (The).
  20. Trane.
- B. Description: Factory-fabricated, -assembled, -tested, and -finished, direct-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, and support structure.
- C. Housings: Formed panels with shaped cutoff; with doors or panels to allow access to internal parts and components.
1. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
  2. Spun inlet cone with flange.
  3. Outlet flange.
- D. Backward-Inclined Wheels: Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange, backplate, backward-inclined blades and fastened to shaft with set screws.
- E. Shafts: Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
1. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
  2. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
- F. Prelubricated and Sealed Shaft Bearings: Self-aligning, pillow-block-type ball bearings.
1. Ball-Bearing Rating Life: ABMA 9, L10 at 50,000 hours.
  2. Roller-Bearing Rating Life: ABMA 11, L10 at 50,000 hours.
- G. Accessories:
1. Scroll Access Doors: Shaped to conform to scroll, with quick-opening latches and gaskets.
  2. Scroll Drain Connection: NPS 1 steel pipe coupling welded to low point of fan scroll.
  3. Companion Flanges: Rolled flanges for duct connections of same material as housing.
  4. Variable Inlet Vanes: With blades supported at both ends with two permanently lubricated bearings of same material as housing. Variable mechanism terminating in single control lever with control shaft for double-width fans.
  5. Inlet Screens: Grid screen of same material as housing.
  6. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
- H. Motors:
1. Enclosure Type: Open Drip-Proof, fan cooled.

## 2.2 SOURCE QUALITY CONTROL

- A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
- B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install centrifugal fans level and plumb.
- B. Support suspended units from structure using threaded steel rods and spring hangers with vertical-limit stops having a static deflection of 1 inch.
- C. Install units with clearances for service and maintenance.

### 3.2 CONNECTIONS

- A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors.
- B. Install ducts adjacent to fans to allow service and maintenance.
- C. Install line-sized piping from scroll drain connection, with trap with seal equal to 1.5 times specified static pressure, to nearest floor drain.

### 3.3 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections:
  - 1. Verify that shipping, blocking, and bracing are removed.
  - 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
  - 3. Verify that cleaning and adjusting are complete.
  - 4. Verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation.
  - 5. Adjust damper linkages for proper damper operation.
  - 6. Verify lubrication for bearings and other moving parts.
  - 7. Verify that manual and automatic volume control dampers in connected ductwork systems are in fully open position.
  - 8. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 233416

## **SECTION 233713**

### **DIFFUSERS, REGISTERS, AND GRILLES**

#### **PART 1 - GENERAL**

##### **1.1 SUMMARY**

- A. This Section includes ceiling- and wall-mounted diffusers, registers, and grilles.

##### **1.2 SUBMITTALS**

- A. Product Data: For each product indicated, include the following:
  - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.

#### **PART 2 - PRODUCTS**

##### **2.1 GRILLES AND REGISTERS**

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
  - 1. Krueger HVAC.
  - 2. Nailor Industries of Texas Inc.
  - 3. Price Industries.
  - 4. Titus.

##### **2.2 SOURCE QUALITY CONTROL**

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

#### **PART 3 - EXECUTION**

##### **3.1 EXAMINATION**

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practicable. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

### 3.3 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713

## **SECTION 235216**

### **CONDENSING BOILERS**

#### **PART 1 - GENERAL**

##### **1.1 SUMMARY**

- A. This Section includes packaged, factory-fabricated and -assembled, gas-fired, modulating condensing boilers, trim, and accessories for generating hot water.

##### **1.2 SUBMITTALS**

- A. Product Data: For boilers, boiler trim, and accessories. Include performance data, operating characteristics, plans, elevations, sections, details, wiring diagrams, piping diagrams, furnished specialties, and accessories.
- B. Source quality-control test reports.
- C. Field quality-control test reports.
- D. Operation and maintenance data.
- E. Warranty documentation.

##### **1.3 QUALITY ASSURANCE**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.
- C. Boiler shall be supplied and installed in accordance with ASME CSD-1-2009.
- D. ASHRAE/IESNA 90.1 Compliance, latest edition: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements" with thermal efficiencies verified through third party testing by the Hydronics Institute Division of AHRI and listed in the AHRI Certification Directory.
- E. DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N, "Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers."
- F. UL Compliance: Test boilers for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.



## 1.4 WARRANTY

- A. In addition to standard project warranty requirements, the complete heat exchanger assembly shall be covered by a (10) year parts and labor warranty.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Fulton Boiler Works, Inc.
2. Gasmaster Industries Incorporated.
3. Hydrotherm, Inc.; a division of Mestek, Inc.
4. AERCO International.
5. Heat Transfer Products, Inc.
6. Laars Heating Systems; a division of Waterpik Technologies, Inc.
7. Lochinvar Corporation.
8. Viessmann Manufacturing Co. (US) Inc.

### 2.2 MANUFACTURED UNITS

- A. Description: Factory-fabricated, -assembled, and -tested, pulse-combustion condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls.
- B. Heat Exchanger: Stainless-steel. A built-in trap shall allow condensation to drain from the heat exchanger assembly. Heat exchanger shall bear the ASME "H" stamp.
- C. Burner: Modulating, natural gas, forced draft drawing from gas premixing valve.
- D. Blower: Variable speed to precisely control fuel/air mixture to achieve maximum efficiency at various firing rates.
- E. Gas Train: Combination gas valve with manual shutoff and pressure regulator.
- F. Ignition: Spark ignition with 100 percent main-valve shutoff with electronic flame supervision.
- G. Casing:
1. Jacket: Heavy gauge steel jacket assembly, primed and pre-painted on both sides.
  2. A burner/flame observation port shall be provided.
  3. Combustion chamber shall be sealed and completely enclosed, independent of outer jacket assembly, so that integrity of the other outer jacket does not affect a proper seal.
  4. Control Compartment Enclosure: NEMA 250, Type 1A.
  5. Combustion-Air Connection: Inlet and vent duct collars.
  6. Provide with equipment leveling legs and mounting base to secure boiler to concrete base.
- H. Condensate Trap: Cast-iron body with stainless-steel internal parts.

## 2.3 TRIM

- A. Aquastat Controllers: Operating, firing rate, and high limit.
- B. Safety Relief Valve: ASME rated.
- C. Pressure and Temperature Gage: Minimum 3-1/2-inch- diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges so normal operating range is about 50 percent of full range.
- D. Drain Valve: Minimum NPS 3/4 hose-end gate valve.
- E. Circulation Pump: Non-overloading, constant speed, in-line pump with split-capacitor motor having thermal-overload protection and lubricated bearings; designed to operate at specified boiler pressures and temperatures. Powered and controlled by boiler controller.

## 2.4 CONTROLS

- A. Boiler operating controls shall include the following devices and features:
  - 1. Control transformer.
  - 2. Set-Point Adjust: Set points shall be adjustable.
  - 3. Boiler shall include an electronic display for boiler set-up, boiler status, and boiler diagnostics.
  - 4. Boiler shall provide power to and control operation of boiler circulation pump.
- B. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.
  - 1. High Cutoff: Automatic reset stops burner if operating conditions rise above maximum boiler design temperature.
  - 2. Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be automatic-reset type.
  - 3. Blocked Inlet Safety Switch: Manual-reset pressure switch field mounted on boiler combustion-air inlet.
  - 4. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.
- C. Building Management System Interface: Factory install hardware and software to enable building management system to monitor, control, and display boiler status and alarms.
  - 1. A communication interface with building management system shall enable building management system operator to remotely control and monitor the boiler from an operator workstation. Control features available, and monitoring points displayed, locally at boiler control panel shall be available through building management system.

## 2.5 ELECTRICAL POWER

- A. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.
  - 1. House in NEMA 250, Type 1 enclosure.

2. Wiring shall be numbered and color-coded to match wiring diagram.
3. Install factory wiring outside of an enclosure in a metal raceway.
4. Field power interface shall be to circuit breaker.
5. Provide branch power circuit to each motor and to controls with a circuit breaker.
6. Provide each motor with overcurrent protection.

## 2.6 VENTING KITS

- A. Kit: Complete system, ASTM A 959, Type 29-4C stainless steel, pipe, vent terminal, thimble, indoor plate, vent adapter, condensate trap and dilution tank, and sealant.
- B. Combustion-Air Intake: Complete system, stainless steel, pipe, vent terminal with screen, inlet air coupling, and sealant.

## 2.7 SOURCE QUALITY CONTROL

- A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.
- B. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.
- C. If required by any local or state laws, complete and submit all safety inspection forms and submit to the responsible local or state agency and arrange/complete any required inspections. Any inspection permits and inspection fees related to any required local or state inspections are to be paid for by the Contractor. The Contractor is also responsible for any non-compliance fees assessed by the local or state agency governing safety of Boilers and Pressure Vessels

# PART 3 - EXECUTION

## 3.1 BOILER INSTALLATION

- A. Install boilers level on concrete base.
- B. Vibration Isolation: Elastomeric isolation pads or mounts with a minimum static deflection of 0.25 inch.
- C. Install gas-fired boilers according to NFPA 54.
- D. Assemble and install boiler trim.
- E. Install electrical devices furnished with boiler but not specified to be factory mounted.
- F. Install control wiring to field-mounted electrical devices.

## 3.2 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.

- B. Install piping adjacent to boiler to allow service and maintenance.
- C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.
- D. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service.
- E. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas train connection. Provide a reducer if required.
- F. Connect hot-water piping to supply- and return-boiler tapplings with shutoff valve and union or flange at each connection.
- G. Install piping from safety relief valves to nearest floor drain.
- H. Boiler Venting:
  - 1. Install flue venting kit and combustion-air intake.
  - 2. Connect full size to boiler connections.

### 3.3 SOURCE QUALITY CONTROL

- A. If required by any local or state laws, complete and submit all safety inspection forms and submit to the responsible local or state agency and arrange/complete any required inspections. Any inspection permits and inspection fees related to any required local or state inspections are to be paid for by the Contractor. The Contractor is also responsible for any non-compliance fees assessed by the local or state agency governing safety of Boilers and Pressure Vessels.

### 3.4 FIELD QUALITY CONTROL

- A. Engage a factory-authorized service representative to perform startup service.
- B. Perform tests and inspections and prepare test reports.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
  - 1. Perform installation and startup checks according to manufacturer's written instructions.
  - 2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
  - 3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
  - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
    - a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level, and water temperature.
    - b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- D. Remove and replace malfunctioning units and retest as specified above.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain boilers.

END OF SECTION 235216

**SECTION 236423**  
**SCROLL WATER CHILLERS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes: Packaged, air-cooled, electric-motor-driven, scroll water chillers.

**1.2 SUBMITTALS**

- A. Product Data: Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Startup service reports.
- C. Operation and maintenance data.
- D. Warranty.

**1.3 QUALITY ASSURANCE**

- A. ARI Certification: Certify chiller according to ARI 590 certification program.
- B. ARI Rating: Rate water chiller performance according to requirements in ARI 550/590, "Water Chilling Packages Using the Vapor Compression Cycle."
- C. ASHRAE Compliance:
  - 1. ASHRAE 15 for safety code for mechanical refrigeration.
  - 2. ASHRAE Guideline 3 for refrigerant leaks, recovery, and handling and storage requirements.
  - 3. ASHRAE/IESNA 90.1 for energy efficiency.
- D. Comply with NFPA 70.

**1.4 WARRANTY**

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of water chillers that fail in materials or workmanship within specified period.
  - 1. Compressor Warranty Period: Five years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 PACKAGED AIR-COOLED WATER CHILLERS

- A. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or by a comparable product by one of the following:
1. Carrier Corporation; a United Technologies company.
  2. McQuay International.
  3. Trane.
  4. York International Corporation.
- B. Description: Factory-assembled and run-tested water chiller complete with base and frame, condenser casing, compressors, compressor motors and motor controllers, evaporator, condenser coils, condenser fans and motors, electrical power, controls, and accessories.
- C. Cabinet:
1. Base: Galvanized-steel base extending the perimeter of water chiller. Secure frame, compressors, and evaporator to base to provide a single-piece unit.
  2. Frame: Rigid galvanized-steel frame secured to base and designed to support cabinet, condenser, control panel, and other chiller components not directly supported from base.
  3. Casing: Galvanized steel.
  4. Finish: Coat base, frame, and casing with a corrosion-resistant coating capable of withstanding a 500-hour salt-spray test according to ASTM B 117.
  5. Sound-reduction package consisting of the following:
    - a. Acoustic sound blanket around digital compressors, designed to reduce sound level without affecting performance.
- D. Compressors:
1. Description: Positive-displacement direct drive with hermetically sealed casing.
  2. Each compressor provided with suction and discharge service valves, crankcase oil heater, and suction strainer.
  3. Operating Speed: Nominal 3600 rpm for 60-Hz applications.
  4. Capacity Control: On-off compressor cycling or digital compressor where indicated on drawings.
  5. Oil Lubrication System: Automatic pump with strainer, sight glass, filling connection, filter with magnetic plug, and initial oil charge.
  6. Vibration Isolation: Mount individual compressors on vibration isolators.
- E. Compressor Motors:
1. Hermetically sealed and cooled by refrigerant suction gas.
  2. High-torque, two-pole induction type with inherent thermal-overload protection on each phase.
- F. Compressor Motor Controllers:
1. Across the Line: NEMA ICS 2, Class A, full voltage, nonreversing.
- G. Refrigeration:

1. Refrigerant: R-410a. Classified as Safety Group A1 according to ASHRAE 34.
2. Refrigerant Compatibility: Parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.
3. Refrigerant Circuit: Each circuit shall include a thermal-expansion valve, refrigerant charging connections, a hot-gas muffler, compressor suction and discharge shutoff valves, a liquid-line shutoff valve, a replaceable-core filter-dryer, a sight glass with moisture indicator, a liquid-line solenoid valve, and an insulated suction line.
4. Refrigerant Isolation: Factory install positive shutoff isolation valves in the compressor discharge line and the refrigerant liquid-line to allow the isolation and storage of the refrigerant charge in the chiller condenser.

H. Evaporator:

1. Brazed-plate design.
2. Brazed Plate:
  - a. Direct-expansion, single-pass, brazed-plate design.
  - b. Type 316 stainless-steel construction.
  - c. Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code.
  - d. Fluid Nozzles: Terminate with mechanical-coupling end connections for connection to field piping.

I. Air-Cooled Condenser:

1. Plate-fin coil with integral subcooling on each circuit, rated at 450 psig.
  - a. Construct coils of copper tubes mechanically bonded to aluminum fins.
  - b. Coat coils with a baked epoxy corrosion-resistant coating after fabrication.
  - c. Hail Protection: Provide condenser coils with louvers, baffles, or hoods to protect against hail damage.
2. Fans: Direct-drive propeller type with statically and dynamically balanced fan blades, arranged for vertical air discharge.
3. Fan Motors: Totally enclosed nonventilating (TENV) or totally enclosed air over (TEAO) enclosure, with permanently lubricated bearings, and having built-in overcurrent- and thermal-overload protection.
4. Fan Guards: Steel safety guards with corrosion-resistant coating.

J. Electrical Power:

1. Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to water chiller.
2. House in a unit-mounted, NEMA 250, Type 3R enclosure with hinged access door with lock and key or padlock and key.
3. Wiring shall be numbered and color-coded to match wiring diagram.
4. Install factory wiring outside of an enclosure in a raceway.
5. Field power interface shall be to wire lugs.
6. Provide branch power circuit to each motor and to controls with one of the following disconnecting means:
  - a. NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.



- b. NEMA KS 1, heavy-duty, nonfusible switch.
  - c. NEMA AB 1, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
- 7. Provide each motor with overcurrent protection.
- 8. Overload relay sized according to UL 1995, or an integral component of water chiller control microprocessor.
- 9. Phase-Failure and Undervoltage: Solid-state sensing with adjustable settings.
- 10. Transformer: Unit-mounted transformer with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.
  - a. Power unit-mounted controls.
- 11. Control Relays: Auxiliary and adjustable time-delay relays.
- 12. Indicate the following for water chiller electrical power supply:
  - a. Current, phase to phase, for all three phases.
  - b. Voltage, phase to phase and phase to neutral for all three phases.
  - c. Three-phase real power (kilowatts).
  - d. Three-phase reactive power (kilovolt amperes reactive).
  - e. Power factor.
  - f. Running log of total power versus time (kilowatt hours).
  - g. Fault log, with time and date of each.

Controls:

- 13. BACnet communication.
- 14. Enclosure: Share enclosure with electrical power devices or provide a separate enclosure of matching construction.
- 15. Operator Interface: Keypad or pressure-sensitive touch screen. Multiple-character, backlit, liquid-crystal display or light-emitting diodes. Display the following:
  - a. Date and time.
  - b. Operating or alarm status.
  - c. Operating hours.
  - d. Outside-air temperature if required for chilled-water reset.
  - e. Temperature and pressure of operating set points.
  - f. Entering and leaving temperatures of chilled water.
  - g. Refrigerant pressures in evaporator and condenser.
  - h. Saturation temperature in evaporator and condenser.
  - i. No cooling load condition.
  - j. Elapsed time meter (compressor run status).
  - k. Pump status.
  - l. Antirecycling timer status.
  - m. Percent of maximum motor amperage.
  - n. Current-limit set point.
  - o. Number of compressor starts.
- 16. Control Functions:
  - a. Manual or automatic startup and shutdown time schedule.
  - b. Entering and leaving chilled-water temperatures, control set points, and motor load limit.
  - c. Current limit and demand limit.
  - d. External water chiller emergency stop.

- e. Antirecycling timer.
- f. Automatic lead-lag switching.

17. Manual-Reset Safety Controls: The following conditions shall shut down water chiller and require manual reset:

- a. Low evaporator pressure or high condenser pressure.
- b. Low chilled-water temperature.
- c. Refrigerant high pressure.
- d. High or low oil pressure.
- e. High oil temperature.
- f. Loss of chilled-water flow.
- g. Control device failure.

K. Insulation:

- 1. Material: Closed-cell, flexible elastomeric, thermal insulation complying with ASTM C 534, Type I, for tubular materials and Type II, for sheet materials.
- 2. Factory-applied insulation over cold surfaces of water chiller components.
  - a. Adhesive: As recommended by insulation manufacturer and applied to 100 percent of insulation contact surface. Seal seams and joints.
- 3. Apply protective coating to exposed surfaces of insulation.

L. Accessories:

- 1. Factory-furnished, chilled-water flow switches for field installation.
- 2. Individual compressor suction and discharge pressure gages with shutoff valves for each refrigeration circuit.

## 2.2 SOURCE QUALITY CONTROL

- A. If required by any local or state laws, complete and submit all safety inspection forms and submit to the responsible local or state agency and arrange/complete any required inspections. Any inspection permits and inspection fees related to any required local or state inspections are to be paid for by the Contractor. The Contractor is also responsible for any non-compliance fees assessed by the local or state agency governing safety of Boilers and Pressure Vessels.

## PART 3 - EXECUTION

### 3.1 WATER CHILLER INSTALLATION

- A. Install water chillers on support structure indicated.
- B. Equipment Mounting: Install water chiller on concrete bases using factor provided leveling legs.
- C. Maintain manufacturer's recommended clearances for service and maintenance.
- D. Charge water chiller with refrigerant if not factory charged and fill with oil if not factory installed.

- E. Install separate devices furnished by manufacturer and not factory installed.

### 3.2 CONNECTIONS

- A. Install piping adjacent to chiller to allow service and maintenance.
- B. Evaporator Fluid Connections: Connect to evaporator inlet with shutoff valve, strainer, flexible connector, thermometer, and plugged tee with pressure gage. Connect to evaporator outlet with shutoff valve, balancing valve, flexible connector, flow switch, thermometer, plugged tee with pressure gage, and drain connection with valve. Make connections to water chiller with a flange.
- C. Connect each drain connection with a union and drain pipe and extend pipe, full size of connection, to floor drain. Provide a shutoff valve at each connection if required.

### 3.3 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.
- C. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
  - 1. Verify that refrigerant charge is sufficient and water chiller has been leak tested.
  - 2. Verify that pumps are installed and functional.
  - 3. Verify that thermometers and gages are installed.
  - 4. Operate water chiller for run-in period.
  - 5. Check bearing lubrication and oil levels.
  - 6. Verify proper compressor operation.
  - 7. Verify and record performance of chilled-water flow and low-temperature interlocks.
  - 8. Verify and record performance of condenser-water flow and high- and low-temperature interlocks
  - 9. Verify and record performance of water chiller protection devices.
  - 10. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
- D. Prepare a written startup report that records results of tests and inspections.

### 3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain chillers.

END OF SECTION 236423

**SECTION 237313**  
**MODULAR INDOOR CENTRAL STATION AIR HANDLING UNITS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
1. Variable-air-volume, air-handling units.

**1.2 SUBMITTALS**

- A. Product Data: For each air-handling unit indicated.
1. Unit dimensions and weight.
  2. Cabinet material, metal thickness, finishes, insulation, and accessories.
  3. Fans:
    - a. Certified fan-performance curves with system operating conditions indicated.
    - b. Certified fan-sound power ratings.
    - c. Fan construction and accessories.
    - d. Motor ratings, electrical characteristics, and motor accessories.
  4. Certified coil-performance ratings with system operating conditions indicated.
  5. Dampers, including housings, linkages, and operators.
  6. Filters with performance characteristics.
- B. Source quality-control reports.
- C. Operation and maintenance data.

**1.3 QUALITY ASSURANCE**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.
- C. ARI Certification: Air-handling units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI.
- D. Comply with NFPA 70.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Aeon.
2. Air Enterprises, Inc.
3. Airtherm; a Mestek company.
4. Buffalo Air Handling.
5. Carrier Corporation; a member of the United Technologies Corporation Family.
6. Coil Company, LLC.
7. Daikin Applied.
8. Dunham-Bush, Inc.
9. Engineered Air.
10. McQuay International
11. Scott Springfield Mfg. Inc.
12. Trane; American Standard Inc.
13. USA Coil & Air.
14. YORK International Corporation.

### 2.2 UNIT CASINGS

A. General Fabrication Requirements for Casings:

1. Forming: Form walls, roofs, and floors with at least two breaks at each joint.
2. Casing Joints: Sheet metal screws or pop rivets.
3. Sealing: Seal all joints with water-resistant sealant.
4. Factory Finish for Steel and Galvanized-Steel Casings: Apply manufacturer's standard primer immediately after cleaning and pretreating.

B. Casing Insulation and Adhesive:

1. Materials: ASTM C 1071, Type I.
2. Location and Application: Factory applied with adhesive and mechanical fasteners to the internal surface of section panels downstream from, and including, the cooling-coil section.
  - a. Liner Adhesive: Comply with ASTM C 916, Type I.
  - b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
  - c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service-air velocity.
3. Location and Application: Encased between outside and inside casing.

C. Inspection and Access Panels and Access Doors:

1. Panel and Door Fabrication: Formed and reinforced, single- or double-wall and insulated panels of same materials and thicknesses as casing.
2. Inspection and Access Panels:
  - a. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against air-pressure differential.
  - b. Gasket: Neoprene, applied around entire perimeters of panel frames.
  - c. Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.
3. Access Doors:
  - a. Hinges: A minimum of two ball-bearing hinges and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against air-pressure differential.
  - b. Gasket: Neoprene, applied around entire perimeters of panel frames.
  - c. Fabricate windows in doors of double-glazed, wire-reinforced safety glass with an air space between panes and sealed with interior and exterior rubber seals.
  - d. Size: At least 18 inches.
4. Locations and Applications:
  - a. Fan Section: Doors.
  - b. Access Section: Doors.
  - c. Coil Section: Inspection and access panel.
  - d. Damper Section: Inspection and access panels.
  - e. Filter Section: Doors large enough to allow periodic removal and installation of filters.

D. Condensate Drain Pans:

1. Fabricated with slopes in at least 2 planes to collect condensate from cooling coils (including coil piping connections, coil headers and return bends, and a minimum of 6 inches downstream from cooling-coil face) and from humidifiers.
2. Formed sections.
3. Single-wall, galvanized-steel sheet.
4. A minimum of 2 inches deep, and complying with requirements in ASHRAE 62.1.
5. Drain Connections: Both ends of pan with NPS 1 threaded nipple.
6. Pan-Top Surface Coating: Asphaltic waterproofing compound.
7. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

- E. Air-Handling-Unit Mounting Frame: Formed galvanized-steel channel or structural channel supports, designed for low deflection, welded with integral lifting lugs.

2.3 FAN, DRIVE, AND MOTOR SECTION

- A. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
1. Shafts: Designed for continuous operation at maximum-rated fan speed and motor horsepower, and with field-adjustable alignment.

- a. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
    - b. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
  - B. Centrifugal Fan Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.
    1. Bracing: Steel angle or channel supports for mounting and supporting fan scroll, wheel, motor, and accessories.
    2. Horizontal-Flanged, Split Housing: Bolted construction.
    3. Housing for Supply Fan: Attach housing to fan-section casing with metal-edged flexible duct connector.
    4. Flexible Connector: Factory fabricated and installed.
  - C. Plug Fans Housings: Steel cabinet; fabricated without fan scroll and volute housing.
  - D. Backward-Inclined, Centrifugal Fan Wheels: Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange, backplate, backward-inclined blades welded or riveted to flange and backplate; cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.
  - E. Forward-Curved, Centrifugal Fan Wheels: Inlet flange, backplate, and shallow blades with inlet and tip curved forward in direction of airflow and mechanically fastened to flange and backplate; cast-steel hub swaged to backplate and fastened to shaft with set screws.
  - F. Fan Shaft Bearings:
    1. Grease-Lubricated Bearings: Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing with grease lines extended to outside unit and a rated life of 200,000 hours according to ABMA 11.
  - G. Internal Vibration Isolation: Fans shall be factory mounted with manufacturer's standard vibration isolation mounting devices having a minimum static deflection of 1 inch.
    1. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment." Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
    2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
    3. Mount unit-mounted disconnect switches on exterior of unit.
- 2.4 COIL SECTION
- A. General Requirements for Coil Section:
    1. Comply with ARI 410.
    2. Fabricate coil section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
    3. Coils shall not act as structural component of unit.

## 2.5 AIR FILTRATION SECTION

### A. General Requirements for Air Filtration Section:

1. Comply with NFPA 90A.
2. Provide minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
3. Provide filter holding frames arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.

### B. Disposable Panel Filters:

1. Factory-fabricated, viscous-coated, flat-panel type.
2. Thickness: 2 inches.
3. Recommended Final Resistance: 1.00 inches wg.
4. Merv (ASHRAE 52.2): 8.
5. Media: Interlaced glass fibers sprayed with nonflammable adhesive.
6. Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, hinged, and with pull and retaining handles.

### C. Filter Gage:

1. 2-inch-diameter, diaphragm-actuated dial in metal case.
2. Vent valves.
3. Black figures on white background.
4. Front recalibration adjustment.
5. 2 percent of full-scale accuracy.
6. Range: 0- to 2.0-inch wg.
7. Accessories: Static-pressure tips with integral compression fittings, 1/4-inch plastic tubing, and 2- or 3-way vent valves.

## 2.6 DAMPERS

### A. Electronic Damper Operators:

1. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
2. Electronic damper position indicator shall have visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
3. Operator Motors:
  - a. Size to operate with sufficient reserve power to provide smooth modulating action.
4. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.
5. Size dampers for running torque calculated as follows:
  - a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
  - b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
6. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
7. Fail-Safe Operation: Mechanical, spring-return mechanism with external, manual gear release on nonspring-return actuators.



## 2.7 HEAT WHEELS

### A. General Requirements:

1. The energy recovery cassette shall incorporate a rotary wheel in an insulated cassette frame.
2. Energy recovery wheel performance shall be AHRI 1060 certified and bear the AHRI certified label. Components that are independently tested or "rated in accordance with" shall not be acceptable. Manufacturer membership in AHRI is not an acceptable substitute. Certified components must be listed as active in the AHRI Directory. ([www.ahridirectory.org](http://www.ahridirectory.org))
3. The energy recovery cassette shall be an Underwriters Laboratory UR recognized component for fire and electrical safety and bear the UR symbol. Recognized components shall be listed in the UL directory. (<http://database.ul.com>)
4. The energy recovery cassette shall comply with NFPA 90A by virtue of the UL standard 1812 and UL900 fire test for determination of flammability and smoke density.

### B. Casing:

1. Steel with standard factory-painted finish.
2. Integral purge section limiting carryover of exhaust air to between 0.05 percent at 1.6-inch wg and 0.20 percent at 4-inch wg differential pressure.
3. Casing seals on periphery of rotor and on duct divider and purge section.

### C. Rotor:

1. Support vertical rotors on grease-lubricated ball bearings having extended grease fittings. Support horizontal rotors on tapered roller bearing.
2. Rotor: Aluminum segmented wheel strengthened with radial spokes, with nontoxic, noncorrosive, silica-gel or molecular sieve desiccant coating.

### D. Seals:

1. All diameter and perimeter seals shall be provided as part of the cassette assembly and shall be factory set.
2. Seals shall be non-contact nylon pile brush seal oriented in a labyrinth style configuration.
3. Diameter seals shall be fully adjustable and easily accessible.

### E. Motor:

1. Drive: Fractional horsepower motor and gear reducer and self-adjusting multilink belt around outside of rotor.
  - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
  - b. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

### F. Controls:

1. Starting relay, factory mounted and wired, and manual motor starter for field wiring.
2. Variable frequency controller, factory mounted and wired, with exhaust- and outdoor-air sensors, automatic changeover thermostat and set-point adjuster, to vary rotor speed and maintain exhaust temperature above freezing and air differential temperature above

- set point. Provide maximum rotor speed when exhaust-air temperature is less than outdoor-air temperature.
- 3. Pilot-Light Indicator: Display rotor rotation and speed.
- 4. Speed Settings: Adjustable settings for maximum and minimum rotor speed limits.

## 2.8 CAPACITIES AND CHARACTERISTICS

### A. Casing:

- 1. Outside Casing: Galvanized steel, minimum 24 gauge.
- 2. Inside Casing: Galvanized steel, solid, minimum 24 gauge.
- 3. Floor Plate: Galvanized steel, minimum 24 gauge.
- 4. Insulation Thickness: 2 inches.

### B. Supply Fan:

- 1. Class I: AMCA 99-2408.
- 2. Drive: Direct.
- 3. Type: Aluminum, axial blade, plenum fan.
- 4. Number of Fan Wheels: One.

### C. Return/Exhaust Fan:

- 1. Class I: AMCA 99-2408.
- 2. Drive: Direct.
- 3. Type: Aluminum, axial blade, plenum fan.
- 4. Number of Fan Wheels: One.

### D. Heating Coil:

- 1. Maximum Face Velocity: 500 fpm.
- 2. Fin Material: Aluminum.
- 3. Fin Spacing: 12 fins per inch..
- 4. Headers:
  - a. Cast iron with drain and air vent tappings.
  - b. Seamless copper tube with brazed joints, prime coated.
  - c. Fabricated steel, with brazed joints, prime coated.
  - d. Provide insulated cover to conceal headers exposed outside casings.
- 5. Coil Working-Pressure Ratings: 200 psig, 325 deg F.
- 6. Fluid: Water.

### E. Cooling Coil:

- 1. Maximum Face Velocity: 500 fpm.
- 2. Fin Material: Aluminum.
- 3. Fin Spacing: 12 fins per inch.
- 4. Headers:
  - a. Cast iron with drain and air vent tappings.
  - b. Seamless copper tube with brazed joints, prime coated.
  - c. Fabricated steel, with brazed joints, prime coated.
  - d. Provide insulated cover to conceal headers exposed outside casings.

- 5. Coil Working-Pressure Ratings: 200 psig, 325 deg F.
- 6. Fluid: Water.

## 2.9 SOURCE QUALITY CONTROL

- A. Fan Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.
- B. Fan Performance Rating: Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency. Rate performance according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating."
- C. Water Coils: Factory tested to 300 psig according to ARI 410 and ASHRAE 33.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Suspended Units: Suspend units from structural-steel support frame using threaded steel rods and spring hangers.
- B. Arrange installation of units to provide access space around air-handling units for service and maintenance.
- C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.
- D. Install filter-gage, static-pressure taps upstream and downstream of filters. Mount filter gages on outside of filter housing or filter plenum in accessible position. Provide filter gages on filter banks, installed with separate static-pressure taps upstream and downstream of filters.
- E. Comply with requirements for piping specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- F. Install piping adjacent to air-handling unit to allow service and maintenance.
- G. Connect piping to air-handling units with flexible connectors.
- H. Connect condensate drain pans. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.
- I. Hot- and Chilled-Water Piping: Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.
- J. Connect duct to air-handling units with flexible connections.

END OF SECTION 237313

## **SECTION 238219 FAN COIL UNITS**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. This Section includes fan-coil units and accessories.

#### **1.2 SUBMITTALS**

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Operation and maintenance data.

#### **1.3 QUALITY ASSURANCE**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Units shall be tested and certified in accordance with ARI 440 and UL 1995.

### **PART 2 - PRODUCTS**

#### **2.1 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
  - 1. Carrier Corporation.
  - 2. Daikin Applied.
  - 3. YORK International Corporation.
  - 4. Modine HVAC.
  - 5. Multiaqua, Inc.

#### **2.2 DUCTED FAN-COIL UNITS**

- A. Description: Factory-assembled, horizontal, ceiling suspended, fan coil unit with cabinet. Unit shall be complete with water coils, fan(s), motor(s), and drain pan.

- B. Factory-packaged and -tested units rated according to ARI 440, ASHRAE 33, and UL 1995.
- C. Coil Section Insulation: 1/2-inch thick foil-faced glass fiber or closed-cell foam complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.
- D. Drain Pans: Plastic, Stainless steel, or Insulated galvanized steel with plastic liner formed to slope from all directions to the drain connection as required by ASHRAE 62.
- E. Chassis: Galvanized steel where exposed to moisture, with baked-enamel finish and removable access panels.
- F. Cabinets: Steel with baked-enamel finish in manufacturer's standard paint color.
  - 1. Dampers: Galvanized steel with extruded-vinyl blade seals, flexible-metal jamb seals, and interlocking linkage.
- G. Filters: 1-inch fiberglass throwaway filter.
- H. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain.
- I. Direct-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, multispeed motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.
- J. Belt-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the cabinet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.
- K. Basic Unit Controls:
  - 1. Control voltage transformer.
  - 2. 24-volt controls by others

## 2.3 CEILING CASSETTE FAN-COIL UNITS

- A. Description: Factory-assembled, downward discharge, in-ceiling mounted fan coil. Unit shall be complete with water coils, fan(s), motor(s), condensate pump, fascia, and drain pan.
- B. Coil Section Insulation: 1/2-inch thick, foil-covered glass fiber or closed-cell foam complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.
- C. Drain Pans: Stainless steel formed to slope from all directions to the drain connection as required by ASHRAE 62.
- D. Cabinets: Galvanized steel.
  - 1. Fascia shall be constructed of high impact polystyrene.
  - 2. Air outlet vanes shall be fully insulated aluminum.
- E. Filters: Cleanable.

- F. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain.
- G. Direct-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, multispeed motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.
- H. Basic Unit Controls:
  - 1. Control voltage transformer.
  - 2. 24-volt controls by others.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Install fan-coil units to comply with NFPA 90A.
- B. Suspend fan-coil units from structure with elastomeric hangers.
- C. Install new filters or clean washable filters in each fan-coil unit within two weeks after Substantial Completion.
- D. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
  - 1. Install piping adjacent to machine to allow service and maintenance.
  - 2. Connect condensate drain to indirect waste.
    - a. Install condensate trap of adequate depth to seal against the pressure of fan.
    - b. Install cleanouts in piping at changes of direction.
- E. Connect supply and return ducts to fan-coil units with flexible duct connectors. Comply with safety requirements in UL 1995 for duct connections.

#### **3.2 FIELD QUALITY CONTROL**

- A. Perform the following field tests and inspections:
  - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
- B. Remove and replace malfunctioning units and retest as specified above.

#### **3.3 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fan-coil units.

END OF SECTION 238219

## **SECTION 238239 UNIT HEATERS**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. Section Includes:
  - 1. Fan-forced wall heaters with electric-resistance heating coils.

#### **1.2 SUBMITTALS**

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each product indicated.
- B. Operation and Maintenance Data.

#### **1.3 QUALITY ASSURANCE**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

### **PART 2 - PRODUCTS**

#### **2.1 WALL HEATERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
  - 1. Chromalox, Inc.; a division of Emerson Electric Company.
  - 2. Markel Products; a division of TPI Corporation.
  - 3. QMark Electric Heating; a division of Marley Engineered Products.
- B. Description: Factory-assembled, fan-forced wall heater suitable for small area heating.
- C. Cabinets:
  - 1. Backbox: Constructed of heavy gauge galvanized steel and contain knockouts for power wiring.
  - 2. Frame Assembly: Constructed of heavy gauge steel fan panel containing all operational components of the heater assembly.
- D. Electric-Resistance Heating Coils: Non-glowing design consisting of 80/20 nickel-chromium resistance wire enclosed in a steel sheath with brazed copper plate fins. The heating element shall cover the entire air discharge area to ensure uniform heating of all discharge air.



- E. Unit Cover: Louvered front cover constructed of heavy gauge steel with a polyester powder coat finish.
- F. Finish: All sheet metal parts, except for the backbox, shall have powder coat finish in manufacturer's standard color.
- G. Power: Provided with a factory-installed double-pole, single throw ON/OFF switch mounted on the backbox for positive disconnect of power supply and completely concealed by the unit cover.
- H. Fan Motor: Impedance protected, permanently lubricated, totally enclosed rotor.
- I. Controls: Factory-installed and programmed controller integral to unit cabinet. Fan shall be enabled after heating element reaches operating temperature and shall continue to operate the fan after space temperature setpoint has been satisfied and all heated air within the wall heater has been discharged.

## 2.2 ACCESSORIES

- A. Surface Mounting Frame: Constructed of heavy gauge steel designed to mount around the backbox to provide a finished surface installation. Knockouts shall be provided in the surface mounting frame for power wiring and shall align to the knockouts provided in the backbox.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas to receive wall heaters for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in for electrical connections to verify actual locations before wall heater installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install wall heaters level and plumb.

END OF SECTION 238239

## **SECTION 239100**

### **LOUVERS**

#### **PART 1 - GENERAL**

##### **1.1 SUMMARY**

- A. Section includes fixed and operable louvers, frames and accessories.

##### **1.2 REFERENCES**

- A. Air Movement and Control Association International, Inc.:
  - 1. AMCA 500- L - Test Methods for Louvers, Dampers, and Shutters.
- B. Underwriters Laboratories Inc.:
  - 1. UL - Electrical Construction Equipment Directory.
- C. Federal Emergency Management Agency:
  - 1. FEMA 361 – Safe Rooms for Tornadoes and Hurricanes.

##### **1.3 SUBMITTALS**

- A. Shop Drawings: Indicate louver layout plan and elevations, opening and clearance dimensions, tolerances; head, jamb and sill details; blade configuration, screens, blankout areas required, and frames and wiring diagrams.
- B. Product Data: Submit data describing design characteristics, maximum recommended air velocity, design free area, materials and finishes.

##### **1.4 QUALITY ASSURANCE**

- A. Perform Work in accordance with AMCA Certification for Water Penetration, Air Performance, and Wind Driven Rain, in compliance with AMCA 500-L. Attach AMCA seal to louvers.
- B. Perform Work in accordance with specified building codes and manufacturer standards.

##### **1.5 FIELD MEASUREMENTS**

- A. Verify field measurements prior to fabrication.

##### **1.6 COORDINATION**

- A. Coordinate Work with installation of masonry flashings and other building finishing materials.

- B. Coordinate Work with installation of mechanical ductwork and electrical services to motorized devices.

## **PART 2 - PRODUCTS**

### **2.1 WALL LOUVERS - DRAINABLE STYLE**

#### **A. Manufacturers:**

1. Air Balance Inc.; A Division of Mestek Inc.
2. Air Flow Company Inc.
3. Airolite Company, LLC
4. All-Lite Architectural Products
5. American Warming and Ventilating
6. Arrow United Industries
7. Larnes Company
8. Cesco Products; A Division of Mestek, Inc.
9. Construction Specialties, Inc.
10. Dams Incorporated; D. Architectural Metal Solutions Incorporated
11. Greenheck Fan Corporation
12. Industrial Louvers Inc.
13. Louvers & Dampers, Inc.
14. Metal Form Manufacturing
15. NCA Manufacturing Inc.
16. Nystrom, Inc.
17. Pottorff
18. Reliable Products, Inc.
19. Ruskin Company
20. Safe-Air Dowco Products
21. United Enertech
22. Vent Products Company, Inc.

#### **B. Louver Construction: Aluminum.**

#### **C. Louver Panel Thickness: as indicated in Drawings.**

#### **D. Louver Blade Design: Sloped at 45 degrees; dual drain style.**

#### **E. Louver: To permit a minimum of 40 percent free area.**

#### **F. Water Penetration: Not more than 0.01 oz/sq ft of free area at minimum 500 ft / min face velocity.**

### **2.2 ACCESSORIES**

#### **A. Fasteners and Anchors: Stainless steel type.**

#### **B. Primer: Zinc chromate, alkyd type.**

#### **C. Flashings: Of same material as louver frame.**

#### **D. Provide louvers with backdraft dampers where indicated on Drawings.**

- E. Provide louvers with actuated dampers where indicated on Drawings. Actuated dampers to be connected by a common damper linkage and manufacturer installed damper actuator.

## 2.3 FABRICATION

- A. Louver Blade Design: Slope and style as specified for each louver type; reinforced with intermediate stiffeners.
- B. Louver Frame: Mechanically fastened or welded corner joints. Form perimeter of frames with recessed channel to retain backer rod for sealant application.
- C. Screens: Install screen mesh in shaped frame, reinforce corner construction.

## 2.4 FACTORY FINISHING

- A. Exterior Aluminum Surfaces, Screens and Blank-Out Sheeting: Mill finish. Coordinate color with Architect.
- B. Interior Aluminum Surfaces and Blank Out Sheeting: Unfinished.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Verify prepared openings and flashings are ready to receive Work and opening dimensions are as indicated on shop drawings.
- B. Verify electric power is available and of correct characteristics.

## 3.2 INSTALLATION

- A. Install louvers level and plumb.
- B. Install flashings and align louver assembly to ensure moisture shed from flashings and diversion of moisture to exterior.
- C. Secure louvers in opening framing with concealed fasteners, removable or hinged for maintenance purposes.
- D. Install insect screen and frame to interior of louver.
- E. Install Work in accordance with manufacturer's instructions.

## 3.3 ADJUSTING

- A. Adjust operable louvers for freedom of movement of control mechanism. Lubricate operating joints.

3.4 CLEANING

- A. Clean surfaces and components.

END OF SECTION 239100

**SECTION 260500  
COMMON WORK RESULTS FOR ELECTRICAL**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
1. Electrical equipment coordination and installation.
  2. Common electrical installation requirements.

**1.2 COORDINATION**

- A. Contractor must read the entire Specifications covering other branches of Work. Contractor is responsible for coordination of his (her) work with work performed by other trades.
- B. Consult all Contract Documents which may affect the location of any equipment or apparatus furnished under this Work and make minor adjustments in location as necessary to secure coordination.
- C. System layout is schematic and exact locations shall be determined by structural and other conditions. This shall not be construed to mean that the design of the system may be arbitrarily changed. The equipment layout is to fit into the building as constructed and to coordinate with equipment included under other Divisions of Work.
- D. Contractor shall contact the Owner's Representative immediately if he (she) notices any discrepancies or omissions in either the Drawings or Specifications, or if there are any questions regarding the meaning or intent thereof.
- E. Submit all changes, other than minor adjustments, to the Engineer/Architect for approval before proceeding with the work.
- F. The Contractor is required to visit the site and fully familiarize himself or herself concerning all conditions affecting the scope of work. Failure to visit the site shall not relieve the Contractor from any responsibility in the performance of his or her Work.
- G. All workmanship to be of the highest quality in accordance with the best practices of the trade by craftsmen/craftswomen skilled in this particular work.
- H. Coordinate arrangement, mounting, and support of electrical equipment:
1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
  2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
  3. To allow right of way for piping and conduit installed at required slope.
  4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

- I. All buried conduits passing from below the proposed building to the exterior shall pass below the proposed structural footing.
- J. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed.
- K. Coordinate sleeve selection and application with selection and application of firestopping.
- L. Where thermostat locations are shown, the electrical contractor shall provide a recessed wall box with conduit to an accessible location. In areas where surface mounted boxes are required, a surface mounted box and conduit to 10' AFF shall be provided (or to the equipment location, whichever is closer). Thermostat installation and the corresponding low voltage thermostat wiring shall be by the mechanical contractor.

### 1.3 PERMITS, INSPECTIONS AND CODES

- A. File all drawings, pay all fees, and obtain permits and certificate of inspection relative to this Work.
- B. Complete installation shall conform with all applicable Federal, State and Local laws, Codes and Ordinances including, but not limited to the latest approved editions of the following:
  - 1. State Building Codes.
  - 2. Specific Construction Safety Requirements, State Industrial Commission.
  - 3. National Electrical Code (NFPA-70).
  - 4. Life Safety Code, NFPA-101.
  - 5. Occupational Safety and Health Act (OSHA) of 1971 and all amendments thereto.
- C. Nothing contained in the drawings and specifications shall be construed to conflict with these laws, codes, and ordinances and they are hereby included in these specifications.

### 1.4 RECORD DRAWINGS

- A. Record all deviations from the Drawings, on a set of prints and deliver them to the Owner and Owner's Representative upon completion of the work. Special attention to record the location of concealed boxes, service runs shall be made at the point of installation to maintain accuracy.
  - 1. Sufficient dimensional tie points to permanent building features shall be provided for all buried conduits to facilitate future location.

### 1.5 INSPECTION

- A. Contractor shall arrange for and include in his (her) bid, inspection of this work by the appropriate stator or local code authority having jurisdiction.

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- A. Furnish new, undeteriorated materials of a quality not less than what is specified.
- B. Contractor to furnish and install only those brands of equipment mentioned specifically or accepted as substitutes.

## **PART 3 - EXECUTION**

### **3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION**

- A. Furnish all materials, labor, tools, transportation, incidentals, and appurtenances to complete in every detail and leave in working order all items of work called for herein or shown on the accompanying Drawings.
- B. Include any minor items of work necessary to provide a complete and fully operative electrical system which meets all required codes.
- C. Comply with NECA 1.
- D. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- E. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- F. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- G. Right of Way: Give to piping systems installed at a required slope.

### **3.2 PROTECTION AND CLEANING**

- A. Protect all fixtures and equipment against damage from leaks or abuse and pay the cost of repair or replacement of fixtures or equipment made necessary by failure to provide suitable safeguards or protection.
- B. After all fixtures and equipment have been set, thoroughly clean all fixtures and equipment with manufacturers recommended cleaning agents, removing stickers and other foreign matter and leave every part in acceptable condition, clean and ready for use.
- C. Repair all dents and scratches in factory prime or finish coats on all electrical equipment. If damage is excessive, replacement may be required.

END OF SECTION 260500



**SECTION 260519**  
**LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES**

**PART 1 - GENERAL**

1.1 SUMMARY

- A. This Section includes the following:
  - 1. Building wires and cables rated 600 V and less.
  - 2. Connectors, splices, and terminations rated 600 V and less.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

**PART 2 - PRODUCTS**

2.1 STANDARDS

- A. Insulation types, ratings and usage shall be in accordance with the National Electrical Code requirements.
- B. All conductors shall be copper
- C. Unless otherwise noted , minimum wire size for lighting and power branch circuits shall be No. 12 AWG. For control and auxiliary systems the minimum size shall be No. 14 AWG.

2.2 CONDUCTORS AND CABLES

- A. All wire and cable shall be UL listed.
- B. Copper Conductors: Comply with NEMA WC 70.
- C. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN, XHHW, and SO.
  - 1. THHN-THWN and XHHW: 90 degree C temperature rating in dry or wet locations.

- D. Multiconductor Cable: Comply with NEMA WC 70 for metal clad cable, Type MC and Type SO with ground wire.

## 2.3 CONNECTORS AND SPLICES

- A. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.
- B. All components used at wiring terminations, connections and splices shall be UL listed.

## PART 3 - EXECUTION

### 3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

### 3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type THHN-THWN, single conductors in raceway or Type XHHW, single conductors in raceway.
- B. Feeders and Branch Circuits: Type THHN-THWN, single conductors in raceway.
- C. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
- D. Concealed light fixture whips: Metal clad cable (Type MC) limited to six feet in length.
- E. Existing walls and ceilings requiring fishing of cable between access points: Metal clad cable (Type MC).
- F. Class 1 Control Circuits: Type THHN-THWN, in raceway.
- G. Class 2 Control Circuits: Power-limited cable, concealed in building finishes.

### 3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

- C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- E. Support cables according to Division 26 Sections "Hangers and Supports for Electrical Systems."
- F. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."
- G. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- H. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- I. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

END OF SECTION 260519

## **SECTION 260526**

### **GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS**

#### **PART 1 - GENERAL**

##### **1.1 SUMMARY**

- A. This Section includes methods and materials for grounding systems and equipment.
- B. Grounding system shall be in compliance with all requirements of the National Electrical Code.

##### **1.2 QUALITY ASSURANCE**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

#### **PART 2 - PRODUCTS**

##### **2.1 CONDUCTORS**

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
  - 1. Solid Conductors: ASTM B 3.
  - 2. Stranded Conductors: ASTM B 8.
  - 3. Tinned Conductors: ASTM B 33.
  - 4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
  - 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
  - 6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
  - 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

##### **2.2 CONNECTORS**

- A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
  - 1. Pipe Connectors: Clamp type, sized for pipe.

- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

## 2.3 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel; 5/8 inch in diameter by 10 feet or as noted on the Drawings.

## PART 3 - EXECUTION

### 3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger, unless otherwise indicated.
- B. Conductor Terminations and Connections:
  - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
  - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
  - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
  - 4. Connections to Structural Steel: Welded connectors.

### 3.2 EQUIPMENT GROUNDING

- A. A separate equipment grounding conductor, minimum size per NEC, shall be installed in each feeder, branch circuit, and control circuit conduit. Conductor insulation shall be green. DO NOT use conduit as a means for grounding of receptacles or any other such devices.
- B. Conduit system shall be electrically continuous. All enclosures and non-current carrying metals to be grounded. All locknuts must cut through enameled or painted surfaces on enclosures. Where enclosures and non-current carrying metals are isolated from the conduit system, use bonding jumpers with approved clamps.
- C. All new receptacles shall be bonded to a ground conductor using a #12 AEG min. bonding jumper between receptacle terminal and ground conductor. Metal-to-metal contact between the device yoke and the outlet box is not acceptable for either surface mounted boxes or flush type boxes.
- D. Junction boxes and pull boxes shall be bonded by the use of UL listed ground screws or lugs.
- E. Lighting fixtures shall be grounded by the use of a pigtail fastened on bare metal that is free of paint.
- F. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- G. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

### 3.3 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
  - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
  - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
  - 3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.
- C. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

END OF SECTION 260526

## **SECTION 260529 HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. Section includes:
  - 1. Hangers and supports for electrical equipment and systems.

#### **1.2 PERFORMANCE REQUIREMENTS**

- A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

#### **1.3 QUALITY ASSURANCE**

- A. Comply with NFPA 70.

### **PART 2 - PRODUCTS**

#### **2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS**

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Allied Tube & Conduit.
    - b. Cooper B-Line, Inc.; a division of Cooper Industries.
    - c. ERICO International Corporation.
    - d. GS Metals Corp.
    - e. Thomas & Betts Corporation.
    - f. Unistrut; Tyco International, Ltd.
    - g. Wesanco, Inc.
  - 2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
  - 3. Channel Dimensions: Selected for applicable load criteria.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

- C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
  - 1. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
  - 2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
  - 3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
  - 4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
  - 5. Toggle Bolts: All-steel springhead type.
  - 6. Hanger Rods: Threaded steel.

## 2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

## PART 3 - EXECUTION

### 3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as scheduled in NECA 1, where its Table 1 lists maximum spacings less than stated in NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
  - 1. Secure raceways and cables to these supports with two-bolt conduit clamps.



- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

### 3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
  - 1. To Wood: Fasten with lag screws or through bolts.
  - 2. To New Concrete: Bolt to concrete inserts.
  - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
  - 4. To Existing Concrete: Expansion anchor fasteners.
  - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
  - 6. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
  - 7. To Light Steel: Sheet metal screws.
  - 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

### 3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

### 3.4 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
  - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529

**SECTION 260533**  
**RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS**

**PART 1 - GENERAL**

1.1 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.2 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

**PART 2 - PRODUCTS**

2.1 METAL CONDUIT AND TUBING

- A. Rigid Steel Conduit: ANSI C80.1.
- B. EMT: ANSI C80.3.
- C. FMC: Zinc-coated steel.
- D. LFMC: Flexible steel conduit with PVC jacket.
- E. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
  - 1. Fittings for EMT: Steel, compression type. Die cast fittings are not acceptable.
- F. LFMC: Flexible steel conduit with PVC jacket. Made from a continuous length of galvanized cold rolled steel strip, spirally wound. Adjacent strips shall have locked typed construction with all the edges turned in. With an extruded PVC jacket.

2.2 NONMETALLIC CONDUIT AND TUBING

- A. PVC conduit shall be heavy wall, Schedule 40 ultra-violet resistant, UL listed under Standard 651. Conduit shall be suitable for use with 90 degree C insulated wire. Conduit fittings and cement shall be of the same manufacturer.
- B. Fittings for Schedule 40 PVC: Match to conduit or tubing type and material.

## 2.3 BOXES AND ENCLOSURES

- A. Sheet Metal Outlet and Device Boxes: NEMA OS 1,
- B. Cast-Metal Outlet and Device Boxes: NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- C. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- D. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.

## 2.4 SLEEVES FOR RACEWAYS

- A. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- B. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch thickness as indicated and of length to suit application.
- C. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

# PART 3 - EXECUTION

## 3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:
  - 1. Exposed Conduit: Rigid Steel Conduit.
  - 2. Concealed Conduit: EMT.
  - 3. Underground Conduit: Schedule 40 PVC, direct buried.
  - 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
  - 5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Comply with the following indoor applications, unless otherwise indicated:
  - 1. Exposed, Not Subject to Physical Damage: EMT.
  - 2. All other exposed areas: RMC.
  - 3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
  - 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC
  - 5. Damp or Wet Locations: RMC.
  - 6. Raceways for Optical Fiber or Communications Cable: EMT.
  - 7. Boxes and Enclosures: NEMA 250, Type 1, or as required for environmental conditions expected.
- C. Minimum Raceway Size: 3/4-inch trade size Raceway Fittings: Compatible with raceways and suitable for use and location.
  - 1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.

### 3.2 INSTALLATION

- A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.
- B. In finished areas, conduit must be concealed above accessible ceilings, within the building structure, or within chases. Exposed conduits to be run tight to wall or ceiling and installed in a neat workmanlike manner, ready for painting.
- C. Install conduit parallel or perpendicular to building lines (except where run in or below floor slabs). Keep conduit runs as closed to underside of structure as possible.
- D. Exercise necessary precautions to prevent accumulation of water, dirt, or concrete in conduits during execution of electrical work. Conduit in which water or foreign material has been permitted to accumulate shall be thoroughly cleaned, or replaced where such accumulations cannot be removed.
- E. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- F. Complete raceway installation before starting conductor installation.
- G. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."
- H. Arrange stub-ups so curved portions of bends are not visible above the finished slab.
- I. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.
- J. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
- K. Raceways below slabs:
  - 1. Minimum conduit size shall be 1".
  - 2. Change from PVC conduit to rigid steel conduit before rising above floor.
- L. Raceway below grade: Install warning tape a minimum of six (6) inches below grade and not less than twelve (12) inches above the raceway.
- M. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.
- N. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 240-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.
- O. Raceways for Optical Fiber and Communications Cable: Install as follows:
  - 1. 3/4-Inch Trade Size and Smaller: Install raceways in maximum lengths of 50 feet.
  - 2. 1-Inch Trade Size and Larger: Install raceways in maximum lengths of 75 feet.
  - 3. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

- P. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
  2. Where otherwise required by NFPA 70.
- Q. Flexible Conduit Connections: Use maximum of 72 inches of flexible conduit for recessed and semi-recessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
- R. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.
1. Wall boxes in tile, marble, brick or other finished masonry wall shall be of welded construction and designed for installation within masonry.
- S. Set metal floor boxes level and flush with finished floor surface.
- T. Metal boxes cast in concrete shall be designed for concrete installation.
- U. Weather-proof boxes shall be die cast aluminum.
- V. Boxes for exposed work in finished area to be Type FS with threaded hubs and rigid conduit risers.
- W. Install expansion fittings at all locations where conduits cross building expansion joints.
- X. Secure rigid conduit at cabinets and boxes using insulated throat type grounding and bonding bushings. Locknuts shall be tightened to cut through painted surfaces.
- Y. Where a number of conduits are to be run exposed and parallel, one with another, they shall be grouped and supported by trapeze hangers or unistrut racks tight to the building structure.
- Z. Mount junction and pull boxes securely to building structure in a location that meets the requirements of the National Electrical Code for accessibility and work space clearance. Coordinate exact locations of work with other trades. Unless noted otherwise, mounting heights shall be (all measurements are to the top of the box):

|                                                                   |                                                                                 |
|-------------------------------------------------------------------|---------------------------------------------------------------------------------|
| Switches, receptacles, or telephone/data shown above a countertop | 12" above countertop                                                            |
| Dedicated receptacles (i.e. refrigerator, microwave, etc.)        | To suit equipment (see equipment/cabinetry elevation drawings where applicable) |
| Other interior receptacles                                        | 16" AFF                                                                         |
| Exterior receptacles                                              | 20" above finished grade                                                        |
| Other switches                                                    | 48" AFF                                                                         |
| Telephone/data shown next to a doorway                            | 56" AFF                                                                         |
| Other telephone/data                                              | 16" AFF                                                                         |

### 3.3 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Rectangular Sleeve Minimum Metal Thickness:
  - 1. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 0.052 inch.
  - 2. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 0.138 inch.
- E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- F. Cut sleeves to length for mounting flush with both surfaces of walls.
- G. Extend sleeves installed in floors 2 inches above finished floor level.
- H. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway unless sleeve seal is to be installed.
- I. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.
- J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
- K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with firestop materials.
- L. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.
- M. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

### 3.4 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

END OF SECTION 260533

## **SECTION 260553**

### **IDENTIFICATION FOR ELECTRICAL SYSTEMS**

#### **PART 1 - GENERAL**

##### **1.1 SUMMARY**

- A. This Section includes the following:
  - 1. Identification for conductors and communication and control cable.
  - 2. Data/Telephone outlet labels
  - 3. Receptacle labels
  - 4. Warning labels and signs.
  - 5. Instruction signs.
  - 6. Equipment identification labels.
  - 7. Miscellaneous identification products.

##### **1.2 QUALITY ASSURANCE**

- A. Comply with NFPA 70.
- B. Comply with 29 CFR 1910.145.

##### **1.3 COORDINATION**

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

#### **PART 2 - PRODUCTS**

##### **2.1 CONDUCTOR AND COMMUNICATION- AND CONTROL-CABLE IDENTIFICATION MATERIALS**

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.
- B. Marker Tape: Vinyl or vinyl -cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

##### **2.2 DATA/TELEPHONE OUTLET LABELS**

- A. Machine printed paper insert with black filled lettering located under clear label cover on face of plate and durable wire markers on inside of outlet box.



## 2.3 RECEPTACLE LABELS

- A. Hot stamped machine printing with black filled lettering on clear background on face of plate and durable wire markers on inside of outlet box.

## 2.4 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.
- C. Color Scheme
  - 1. Emergency Warning labels: White background with red letters
  - 2. All other warning labels: Yellow background with black letters
- D. Warning label and sign shall include, but are not limited to, the following legends:
  - 1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
  - 2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."
  - 3. Junction boxes containing emergency circuits: "EMERGENCY CIRCUITS- PANEL *insert name*"
  - 4. As noted on drawings.

## 2.5 INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. in. and 1/8 inch thick for larger sizes.
  - 1. Engraved legend with black letters on white face. (White letters on red background for emergency information)
  - 2. Punched or drilled for mechanical fasteners.
  - 3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

## 2.6 EQUIPMENT IDENTIFICATION LABELS

- A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for fasteners, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch.
- B. Fasteners for Labels: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

## 2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

- B. Covers for all junction boxes containing emergency circuits shall be red.

### **PART 3 - EXECUTION**

#### **3.1 APPLICATION**

- A. Auxiliary Electrical Systems Conductor and Cable Identification: Use marker tape to identify field-installed alarm, control, signal, sound, intercommunications, voice, and data wiring connections.
1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and cable pull points. Identify by system and circuit designation.
  2. Use system of designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
- B. Data/Telephone Outlet Identification: Use outlet labels to identify each outlet connection. Use system of designation that is uniform and consistent with cable identification. Label face of plate and wire markers inside of box,
- C. Receptacle Identification: Use labels to identify panelboard and circuit number from which served. Label face of plate and wire markers inside of box,
- D. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply self-adhesive warning labels. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.
1. Equipment with Multiple Power or Control Sources: Apply to door or cover of equipment including, but not limited to, the following:
    - a. Power transfer switches.
    - b. Controls with external control power connections.
  2. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.
- E. Instruction Signs:
1. Emergency Operating Instructions: Install instruction signs with white legend on a red background with minimum 3/8-inch- high letters.
- F. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
1. Labeling Instructions:
    - a. Indoor Equipment: Engraved, laminated acrylic or melamine label, drilled for screw attachment. Unless otherwise indicated, provide a single line of text with

1/2-inch- high letters on 1-1/2-inch- high label; where 2 lines of text are required, use labels 2 inches high.

- b. Outdoor Equipment: Engraved, laminated acrylic or melamine label, drilled for screw attachment.
- c. Elevated Components: Increase sizes of labels and legend to those appropriate for viewing from the floor.

2. Equipment to Be Labeled:

- a. New panelboards, electrical cabinets, and enclosures.
- b. Inverters
- c. Disconnect switches.
- d. Contactors.
- e. Timeclocks
- f. Fire alarm control panel and annunciators
- g. Motor control switches including Hand/Off/Auto switches

3.2 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Attach non-adhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.
- F. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Use the colors listed below for ungrounded feeder, and branch-circuit conductors.
  - 1. Color shall be factory applied or for sizes larger than No. 10 AWG field applied
  - 2. Colors for 208/120-V Circuits:
    - a. Phase A: Black.
    - b. Phase B: Red.
    - c. Phase C: Blue.
  - 3. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

END OF SECTION 260553

## **SECTION 260923 LIGHTING CONTROL DEVICES**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. This Section includes lighting control devices shown on the Drawings.

#### **1.2 SUBMITTALS**

- A. Product Data: For each product on the Drawings.
- B. Shop Drawings: For each lighting switching schematic shown in the Drawings, provide a separate wiring diagram with wire types, quantities, and devices necessary to provide the functionality indicated on the drawings. Generic wiring diagrams will not be acceptable.
- C. Operation and Maintenance Data: Provide (3) hard copies in separate 3-ring binders and an electronic copy. Include the following:
  - 1. Operating Instructions
  - 2. Wiring diagrams
  - 3. As-built settings

#### **1.3 QUALITY ASSURANCE**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

#### **1.4 COORDINATION**

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

### **PART 2 - PRODUCTS**

#### **2.1 LIGHTING CONTROL DEVICES**

- A. Provide lighting control devices required to provide the lighting control sequence of operations shown on the Drawings.

## 2.2 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No.14 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

## PART 3 - EXECUTION

### 3.1 SENSOR INSTALLATION

- A. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

### 3.2 WIRING INSTALLATION

- A. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 3/4 inch.
- B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

### 3.3 IDENTIFICATION

- A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."
  - 1. Identify controlled circuits in lighting time switches.
- B. Label time switches and contactors with a unique designation.

### 3.4 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:

1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
  2. Operational Test: Verify operation of each lighting control device, and adjust time delays.
- B. Lighting control devices that fail tests and inspections are defective work.

END OF SECTION 260923

## **SECTION 262416 PANELBOARDS**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. Section includes:
  - 1. Distribution panelboards.
  - 2. Lighting and appliance branch-circuit panelboards.

#### **1.2 SUBMITTALS**

- A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
  - 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
  - 2. Detail enclosure types and details for types other than NEMA 250, Type 1.
  - 3. Detail bus configuration, current, and voltage ratings.
  - 4. Short-circuit current rating of panelboards and overcurrent protective devices.
  - 5. Include evidence of NRTL listing for series rating of installed devices.
  - 6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
  - 7. Include wiring diagrams for power, signal, and control wiring.
  - 8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards.

#### **1.3 QUALITY ASSURANCE**

- A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA PB 1.
- D. Comply with NFPA 70.

#### **1.4 COORDINATION**

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment,

raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

## PART 2 - PRODUCTS

### 2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. Enclosures: Flush- and surface-mounted cabinets.
  - 1. Rated for environmental conditions at installed location.
    - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
  - 2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
  - 3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
  - 4. Finishes:
    - a. Panels and Trim: Steel and galvanized steel factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
    - b. Back Boxes: Galvanized steel.
  - 5. Directory Card: Inside panelboard door, mounted in transparent card holder.
- B. Incoming Mains Location: Top and bottom.
- C. Phase, Neutral, and Ground Buses:
  - 1. Hard-drawn copper, 98 percent conductivity.
  - 2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
- D. Conductor Connectors: Suitable for use with conductor material and sizes.
  - 1. Material: Hard-drawn copper, 98 percent conductivity.
  - 2. Main and Neutral Lugs: Mechanical type.
  - 3. Ground Lugs and Bus Configured Terminators: Mechanical type.
  - 4. Feed-Through Lugs (When required): Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
  - 5. Subfeed (Double) Lugs (When required): Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
- E. Service Equipment Label (When applicable): NRTL labeled for use as service equipment for panelboards with one or more main service disconnecting and overcurrent protective devices.
- F. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- G. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.



## 2.2 DISTRIBUTION PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  3. Square D; a brand of Schneider Electric.
  4. Siemens
- B. Panelboards: NEMA PB 1, power and feeder distribution type.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
- D. Mains: Circuit breaker or main lugs only as noted on Drawings.
- E. Branch Overcurrent Protective Devices: For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
- F. Branch Overcurrent Protective Devices: For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

## 2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  3. Square D; a brand of Schneider Electric.
  4. Siemens
- B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
  2. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
  3. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
    - a. Standard frame sizes, trip ratings, and number of poles.
    - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
    - c. Shunt Trip (When indicated or required): 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
    - d. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.
    - e. Handle Padlocking Device (When indicated or required): Fixed attachment, for locking circuit-breaker handle in on or off position.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Receive, inspect, handle, store and install panelboards and accessories according to NEMA PB 1.1.
- B. Mount top of trim 90 inches Insert height above finished floor unless otherwise required keep the distance from the floor to top most circuit breaker within the height limitation contained in the NEC.
- C. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- D. Install overcurrent protective devices and controllers not already factory installed.
  - 1. Set field-adjustable, circuit-breaker trip ranges.
- E. Install filler plates in unused spaces.
- F. Recessed panels: Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future.
- G. Arrange conductors in gutters into groups and bundle and wrap with wire ties.
- H. Comply with NECA 1.

#### **3.2 IDENTIFICATION**

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads and incorporating Owner's final room designations. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

END OF SECTION 262416

## **SECTION 262726 WIRING DEVICES**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. This Section includes the following:
  - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
  - 2. Snap switches.
- B. Related Sections include the following:
  - 1. Division 27 Section "Communications Horizontal Cabling" for workstation outlets.

#### **1.2 SUBMITTALS**

- A. Product Data: For each type of product indicated.

#### **1.3 QUALITY ASSURANCE**

- A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.

### **PART 2 - PRODUCTS**

#### **2.1 MANUFACTURERS**

- A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
  - 1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
  - 2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
  - 3. Leviton Mfg. Company Inc. (Leviton).
  - 4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

## 2.2 STRAIGHT BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
  - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
  - 2. Products: Subject to compliance with requirements, provide one of the following:
    - a. Cooper; 5351 (single), 5352 (duplex).
    - b. Hubbell; HBL5351 (single), CR5352 (duplex).
    - c. Leviton; 5891 (single), 5352 (duplex).
    - d. Pass & Seymour; 5381 (single), 5352 (duplex).
- B. Tamper-Resistant Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
  - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
  - 2. Products: Subject to compliance with requirements, provide one of the following:
    - a. Cooper; TRBR20.
    - b. Hubbell; BR20TR.
    - c. Leviton; TCR20

## 2.3 GFCI RECEPTACLES

- A. General Description: Straight blade, feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.
- B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
  - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
  - 2. Products: Subject to compliance with requirements, provide one of the following:
    - a. Cooper; GF20.
    - b. Pass & Seymour; 2084.

## 2.4 CORD AND PLUG SETS

- A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.
  - 1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.
  - 2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

## 2.5 SNAP SWITCHES

- A. Comply with NEMA WD 1 and UL 20.
- B. Switches, 120/277 V, 20 A:
  - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).
    - b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
    - c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
    - d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).
- C. Motor Disconnect Switches: Voltage, HP, poles, and operation to suit load served.

## 2.6 WALL PLATES

- A. Single and combination types to match corresponding wiring devices.
  - 1. Plate-Securing Screws: Metal with head color to match plate finish.
  - 2. Material for Finished Spaces: Steel with white baked enamel, suitable for field painting
  - 3. Material for Unfinished Spaces: Galvanized steel.
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant, die-cast aluminum with lockable cover.

## 2.7 FINISHES

- A. Color: Wiring device catalog numbers in Section Text do not designate device color.
  - 1. Wiring Devices Connected to Normal Power System: White, unless otherwise indicated or required by NFPA 70 or device listing.
  - 2. Wiring Devices Connected to Emergency Power System: Red.

## PART 3 - EXECUTION

### 3.1 RECEPTACLE APPLICATION

- A. In all areas accessible to students: Tamper Resistant receptacles
- B. In areas not accessible to students: Standard receptacles
- C. Where required by the most recent version of the NEC and as indicated on the plan sheets: GFCI receptacles

### 3.2 INSTALLATION

- A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.
- B. Coordination with Other Trades:
  - 1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
  - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
  - 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
  - 4. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
  - 1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
  - 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
  - 3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
  - 4. Existing Conductors:
    - a. Cut back and pigtail, or replace all damaged conductors.
    - b. Straighten conductors that remain and remove corrosion and foreign matter.
    - c. Pigtailing existing conductors is permitted provided the outlet box is large enough.
- D. Device Installation:
  - 1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
  - 2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
  - 3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
  - 4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
  - 5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
  - 6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
  - 7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
  - 8. Tighten unused terminal screws on the device.
  - 9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.
- E. Receptacle Orientation:
  - 1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.

- F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.
- G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.
- H. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

### 3.3 IDENTIFICATION

- A. Comply with Division 26 Section "Identification for Electrical Systems."
  - 1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

END OF SECTION 262726

## SECTION 262816 ENCLOSED SWITCHES AND CIRCUIT BREAKERS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes the following individually mounted, enclosed switches and circuit breakers:
  - 1. Fusible switches.
  - 2. Nonfusible switches.
  - 3. Enclosures.

#### 1.2 SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
  - 1. Enclosure types and details for types other than NEMA 250, Type 1.
  - 2. Current and voltage ratings.
  - 3. Short-circuit current rating.

#### 1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

#### 1.4 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.



## 2.2 FUSIBLE AND NONFUSIBLE SWITCHES

### A. Manufacturers:

1. Eaton Corporation; Cutler-Hammer Products.
2. General Electric Co.; Electrical Distribution & Control Division.
3. Square D/Group Schneider.
4. Siemens

### B. Fusible Switch, 600 A and Smaller: NEMA KS 1, Type Heavy Duty, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

### C. Non-fusible Switch, 600 A and Smaller: NEMA KS 1, Type Heavy Duty Duty, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

### D. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded, and bonded; and labeled for copper and aluminum neutral conductors. ( If required)

## 2.3 ENCLOSURES

### A. NEMA AB 1 and NEMA KS 1 to meet environmental conditions of installed location.

1. Outdoor Locations: NEMA 250, Type 3R.
2. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
4. As noted in the drawings.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- #### A. Comply with applicable portions of NECA 1, NEMA PB 1.1, and NEMA PB 2.1 for installation of enclosed switches and circuit breakers.
- #### B. Mount individual wall-mounting switches and circuit breakers with tops at uniform height, unless otherwise indicated. Anchor floor-mounting switches to concrete base.
- #### C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

### 3.2 IDENTIFICATION

- #### A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

- B. Enclosure Nameplates: Label each enclosure with engraved metal or laminated-plastic nameplate as specified in Division 26 Section "Identification for Electrical Systems."

### 3.3 CLEANING

- A. On completion of installation, vacuum dirt and debris from interiors; do not use compressed air to assist in cleaning.
- B. Inspect exposed surfaces and repair damaged finishes.

END OF SECTION 262816

## **SECTION 263323 CENTRAL BATTERY EQUIPMENT**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. This Section includes fast-transfer central battery inverters with the following features:
  - 1. Output distribution section.
  - 2. Internal maintenance bypass/isolation switch.
  - 3. Emergency-only circuits.

#### **1.2 SUBMITTALS**

- A. Product Data:
  - 1. Electrical ratings, including the following:
    - a. Capacity to provide power during failure of normal ac.
    - b. Inverter voltage regulation and THD of output current.
    - c. Rectifier data.
    - d. Transfer time of transfer switch.
    - e. Data for specified optional features.
  - 2. Transfer switch.
  - 3. Inverter.
  - 4. Battery charger.
  - 5. Batteries.
  - 6. Battery monitoring.
  - 7. Battery-cycle warranty monitor.
- B. Field quality-control test reports.
- C. Operation and maintenance data.

#### **1.3 QUALITY ASSURANCE**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Central Battery Inverter System: UL 924 listed.
- C. Comply with NFPA 70 and NFPA 101.

## 1.4 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace batteries that fail in materials or workmanship within specified warranty period. Special warranty, applying to batteries only, applies to materials only, on a prorated basis, for period specified.
  - 1. Battery Warranty Period: Include the following warranty periods, from date of Substantial Completion:
    - a. Premium, Valve-Regulated, Recombinant, Lead-Calcium Batteries:
      - 1) Full Warranty: One year
      - 2) Pro Rata: 19 years
  - 2. Electronics Warranty: Includes all Electronics except batteries, against defects in material and workmanship for a period of 2 years

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Evenlite's, Liteminder Series Inverter or a comparable product by one of the following:
  - 1. Cooper Industries, Inc.; Sure-Lites Division.
  - 2. Dual-Lite.
  - 3. Hubbell Incorporated; Hubbell Lighting.
  - 4. Lithonia Lighting; Emergency Lighting Systems.
  - 5. Thomas & Betts Corporation; Emergi-Lite Division.
  - 6. Thomas & Betts Corporation; Lightalarms Division.

### 2.2 INVERTER PERFORMANCE REQUIREMENTS

- A. Fast-Transfer Central Battery Inverters: Automatically sense loss of normal ac supply and use a solid-state switch to transfer loads. Transfer in 0.004 second or less from normal supply to battery-inverter supply.
  - 1. Operation: Unit supplies power to output circuits from a single, external, normal supply source. Unit automatically transfers load from normal source to internal battery/inverter source. Retransfer to normal is automatic when normal power is restored.
  - 2. Manual Operation:
    - a. Turning inverter off causes static bypass transfer switch to transfer the load directly to normal ac supply circuit without disturbance or interruption.
    - b. Turning inverter on causes static bypass transfer switch to transfer the load to inverter.

## 2.3 SERVICE CONDITIONS

- A. Environmental Conditions: Inverter system shall be capable of operating continuously in the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Ambient Temperature for Electronic Components: 32 to 98 deg F
2. Relative Humidity: 0 to 95 percent, noncondensing.
3. Altitude: Sea level to 900 feet

## 2.4 INVERTERS

- A. Description: Solid-state type, with the following operational features:

1. Automatically regulate output voltage to within plus or minus 5 percent.
2. Automatically regulate output frequency to within plus or minus 1 Hz, from no load to full load at unit power factor over the operating range of battery voltage.
3. Output Voltage Waveform of Unit: Sine wave with maximum 10 percent THD throughout battery operating-voltage range, from no load to full load.
4. Output Protection: Current-limiting and short-circuit protection.
5. Overload Capability: 125 percent for 10 minutes; 150 percent surge.
6. Brownout Protection: Produces rated power without draining batteries when input voltage is down to 75 percent of normal.

## 2.5 BATTERY CHARGER

- A. Description: Solid-state, automatically maintaining batteries in fully charged condition when normal power is available. With LED indicators for "float" and "high-charge" modes.

## 2.6 BATTERIES

- A. Description: Premium, Valve-Regulated, Recombinant, Lead-Calcium Batteries.

1. Capable of sustaining full-capacity output of inverter unit for minimum of 90 minutes.

## 2.7 ENCLOSURES

- A. NEMA 250, Type 1 steel cabinets with access to components through hinged doors with flush tumbler lock and latch.
- B. Finish: Manufacturer's standard baked-enamel finish over corrosion-resistant prime treatment.

## 2.8 CONTROL AND INDICATION

- A. Description: Group displays, indications, and basic system controls on common control panel on front of central battery inverter enclosure.

- B. Minimum displays, indicating devices, and controls shall include those in lists below. Provide sensors, transducers, terminals, relays, and wiring required to support listed items. Alarms shall include an audible signal and a visual display.
- C. Indications: LCD Display, LED indicators
1. Quantitative Indications:
    - a. Input voltage, each phase, line to line.
    - b. Input current, each phase, line to line.
    - c. System output voltage, each phase, line to line.
    - d. System output current, each phase.
    - e. Output VA
    - f. Battery Voltage
    - g. Battery Current
    - h. Battery Power
    - i. Temperature
    - j. System Days
    - k. Inverter minutes/Events
  2. Basic Status Condition Indications:
    - a. Normal operation.
    - b. Load-on bypass.
    - c. Load-on battery.
    - d. Inverter off.
    - e. Alarm condition exists.
  3. Alarm Indications:
    - a. Alarm Summary
    - b. Bypass. CB Trip
    - c. Startup Fault
    - d. Charger Fault
    - e. Inverter Fault
    - f. Audible Alarm ON/OFF
  4. Controls:
    - a. Inverter on-off.
    - b. Start.
    - c. Battery test.
    - d. Alarm silence/reset.
- D. Include the following minimum array:
1. Ready, normal-power on light.
  2. Charge light.
  3. Inverter supply load light.
  4. Battery voltmeter.
  5. AC output voltmeter with minimum accuracy of 2 percent of full scale.
  6. Load ammeter.
  7. Test switch to simulate ac failure.

- E. Enclosure: Steel, with hinged lockable doors, suitable for floor or wall mounting. Manufacturer's standard corrosion-resistant finish.

## 2.9 OPTIONAL FEATURES

- A. Emergency-Only Circuits: Automatically energize only when normal supply has failed. Disconnect emergency-only circuits when normal power is restored.
- B. Maintenance Bypass/Isolation Switch: Switch is interlocked so it cannot be operated unless static bypass transfer switch is in bypass mode. Switch provides manual selection among the following three conditions without interrupting supply to the load during switching:
  - 1. Full Isolation: Load is supplied, bypassing central battery inverter system. Normal ac input circuit, static bypass transfer switch, and central battery inverter load terminals are completely disconnected from external circuits.
  - 2. Maintenance Bypass: Load is supplied, bypassing central battery inverter system. Central battery inverter ac supply terminals are energized to permit operational checking, but system load terminals are isolated from the load.
  - 3. Normal: Normal central battery inverter ac supply terminals are energized and the load is supplied either through static bypass transfer switch and central battery inverter rectifier-charger and inverter or through battery and inverter.

## 2.10 OUTPUT DISTRIBUTION SECTION

- A. Panelboard: Comply with Division 26 Section "Panelboards" except provide assembly integral to equipment cabinet.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Install system components on wall or floor and attach by bolting.
  - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 2. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
- B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.
- C. Connections: Interconnect system components.
- D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
  - 1. Separately Derived Systems: Make grounding connections to grounding electrodes and bonding connections to metallic piping systems as indicated; comply with NFPA 70.
- E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

- F. Identify equipment and components according to Division 26 Section "Identification for Electrical Systems."

### 3.2 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- B. Perform tests and inspections and prepare test reports.
- C. Tests and Inspections:
  - 1. Inspect interiors of enclosures for integrity of mechanical and electrical connections, component type and labeling verification, and ratings of installed components.
  - 2. Test manual and automatic operational features and system protective and alarm functions.
  - 3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specifications. Certify compliance with test parameters.
  - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 263323



## **SECTION 265100 INTERIOR LIGHTING**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. This Section includes the following:
  - 1. Interior lighting fixtures.
  - 2. Exit signs.
  - 3. Lighting fixture supports.

#### **1.2 SUBMITTALS**

- A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
  - 1. Physical description of lighting fixture including dimensions.
  - 2. Emergency lighting units including battery and charger.
  - 3. Energy-efficiency data.

#### **1.3 QUALITY ASSURANCE**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

#### **1.4 COORDINATION**

- A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

### **PART 2 - PRODUCTS**

#### **2.1 MANUFACTURERS**

- A. See lighting schedule on Drawings.

#### **2.2 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS**

- A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

- B. Metal Parts: Free of burrs and sharp corners and edges.
- C. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

## 2.3 EXIT SIGNS

- A. Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
  - 1. Lamps for AC Operation: LEDs, 70,000 hours minimum rated lamp life.
  - 2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
    - a. Battery: Sealed, maintenance-free, nickel-cadmium type.
    - b. Charger: Fully automatic, solid-state type with sealed transfer relay.
    - c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
    - d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
    - e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
    - f. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

## 2.4 LIGHTING FIXTURE SUPPORT COMPONENTS

- A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.
- B. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.
- B. Support for Lighting Fixtures in or on Grid-Type Suspended Ceilings: Use grid as a support element.
  - 1. Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 6 inches from lighting fixture corners.
  - 2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.

3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.

C. Suspended Lighting Fixture Support:

1. Pendants and Rods: Where longer than 48 inches brace to limit swinging.
2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.

D. Adjust aimable lighting fixtures to provide required light intensities.

E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.2 FIELD QUALITY CONTROL

- A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

END OF SECTION 265100

## **SECTION 265600 EXTERIOR LIGHTING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. This Section includes the following:

- 1. Exterior luminaires.
- 2. Poles and accessories.

#### **1.3 SUBMITTALS**

- A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:
  - 1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
  - 2. Details of installation and construction.
  - 3. Luminaire materials.
  - 4. Lamps, including life, output, and energy-efficiency data.
  - 5. Materials, dimensions, and finishes of poles.
  - 6. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
  - 7. Anchor bolts for poles.

#### **1.4 QUALITY ASSURANCE**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

#### **1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Store poles on decay-resistant-treated skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
- B. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. See lighting schedule on Drawings.

### **2.2 LUMINAIRES, GENERAL REQUIREMENTS**

- A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
- B. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.
- C. Metal Parts: Free of burrs and sharp corners and edges.
- D. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.
- E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
- F. Exposed Hardware Material: Stainless steel.
- G. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
- H. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- I. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

### **2.3 POLES AND SUPPORT COMPONENTS, GENERAL REQUIREMENTS**

- A. Structural Characteristics: Comply with AASHTO LTS-4.
- B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts, unless otherwise indicated.
- C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
  - 1. Materials: Shall not cause galvanic action at contact points.
  - 2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication, unless stainless-steel items are indicated.
  - 3. Anchor-Bolt Template: Plywood or steel.

- D. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."

### **PART 3 - EXECUTION**

#### **3.1 LUMINAIRE INSTALLATION**

- A. Fasten luminaire to indicated structural supports.
- B. Adjust luminaires that require field adjustment or aiming.

#### **3.2 POLE INSTALLATION**

- A. Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.
- B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features, unless otherwise indicated on Drawings:
  - 1. Fire Hydrants and Storm Drainage Piping: 60 inches.
  - 2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet .
  - 3. Trees: 15 feet.
- C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 03 Section "Cast-in-Place Concrete."
- D. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
  - 1. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
  - 2. Install base covers, unless otherwise indicated.
  - 3. Use a short piece of 1/2-inch- diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.
- E. Raise and set poles using web fabric slings (not chain or cable).

#### **3.3 BOLLARD LUMINAIRE INSTALLATION**

- A. Align units for optimum directional alignment of light distribution.
- B. Install on concrete base with top 4 inches above finished grade or surface at bollard location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-Place Concrete."

### 3.4 CORROSION PREVENTION

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
- B. Steel Conduits: Comply with Division 26 Section "Raceway and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

### 3.5 GROUNDING

- A. Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."
  - 1. Install grounding electrode for each pole, unless otherwise indicated.
  - 2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

### 3.6 FIELD QUALITY CONTROL

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.

END OF SECTION 265600

## SECTION 271500 COMMUNICATIONS HORIZONTAL CABLING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Pathways.
  - 2. UTP cabling.
  - 3. Telecommunications outlet/connectors including patch panels.
  - 4. Fiber optic backbone cabling
  - 5. Cabling identification products.

#### 1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control reports.

#### 1.3 HORIZONTAL CABLING DESCRIPTION

- A. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called "permanent link," a term that is used in the testing protocols.
  - 1. Bridged taps and splices shall not be installed in the horizontal cabling.

#### 1.4 PERFORMANCE REQUIREMENTS

- A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA/EIA-568-B.1, when tested according to test procedures of this standard.

#### 1.5 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  - 1. Flame-Spread Index: 25 or less.
  - 2. Smoke-Developed Index: 450 or less.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.



- D. Grounding: Comply with ANSI-J-STD-607-A.

## **PART 2 - PRODUCTS**

### **2.1 PATHWAYS**

- A. Cable Support: Where cable tray is not indicated, NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.
1. Support brackets with cable tie slots for fastening cable ties to brackets.
  2. Lacing bars, spools, J-hooks, and D-rings.
  3. Straps and other devices.
- B. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems."
1. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high and 2-1/2 inches deep.
  2. All fiber optic cable shall be routed in conduit.

### **2.2 UTP CABLE**

- A. Description: 100-ohm, 4-pair UTP, covered with a thermoplastic jacket.
1. Thermoplastic jacket color:
    - a. Data and Telephone Outlets: Blue
  2. Comply with ICEA S-90-661 for mechanical properties.
  3. Comply with TIA/EIA-568-B.1 for performance specifications.
  4. Comply with TIA/EIA-568-B.2, Category 6.
  5. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
    - a. Multipurpose: Type MP or MPG.

### **2.3 TELECOMMUNICATIONS OUTLET/CONNECTORS**

- A. Jacks: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with TIA/EIA-568-B.1.
- B. Workstation Outlets: Single faceplate with number of port assembly connectors per Drawings.
1. Plastic Faceplate: High-impact plastic. Coordinate color with Division 26 Section "Wiring Devices."
  2. For use with snap-in jacks accommodating any combination of UTP work area cords.
  3. Legend: Snap-in, clear-label covers and machine-printed paper inserts.

## 2.4 NETWORK CABINET AND PATCH PANELS

- A. Patch Panels: Contractor shall provide and install a patch panel within a network cabinet for the Middle School addition as shown on the Drawings. All proposed horizontal cabling in these respective areas shall terminate on the patch panel and shall be organized in a neat and workmanlike manner. Patch panel capacity shall be selected by the Contractor and shall provide capacity for at least 125% of the horizontal cabling installed as part of the project.
- B. Network Cabinet: 13U, Wallmount Rack Cabinet, Vented Door, Double Hinged. APC AR100HD to match other existing network cabinets on campus.

## 2.5 FIBER OPTIC BACKBONE CABLING

- A. Fiber Optic Main Server to Network Cabinet in Utility Room 114.
  - 1. 12-strand/6 pair
  - 2. 9/125 micron, single mode
  - 3. Jacket Color- Yellow
  - 4. Comply with TIA/EIA 455-21A
  - 5. Comply with IEC-61754-7
  - 6. Comply with TIA-604-5
  - 7. Terminated on both ends

## 2.6 GROUNDING

- A. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.
- B. Comply with ANSI-J-STD-607-A.

## 2.7 IDENTIFICATION PRODUCTS

- A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
- B. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

## 2.8 SOURCE QUALITY CONTROL

- A. Factory test UTP cables on reels according to TIA/EIA-568-B.1.
- B. Cable will be considered defective if it does not pass tests and inspections.

## **PART 3 - EXECUTION**

### **3.1 WIRING METHODS**

- A. Wiring Method: Install cables within conduit or on hooks in all other places. Cables shall run perpendicular to building framing. Conceal raceway and cables except in unfinished spaces.
- B. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.
- C. Where ceiling data outlets are shown in an area of accessible ceilings, provide cable to location indicated with at least twenty extra feet of cable neatly coiled above ceiling. The cable shall be terminated and labeled but data outlets are not required.

### **3.2 INSTALLATION OF PATHWAYS**

- A. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.
- B. Install manufactured conduit sweeps and long-radius elbows whenever possible.

### **3.3 INSTALLATION OF CABLES**

- A. Comply with NECA 1.
- B. General Requirements for Cabling:
  - 1. Comply with TIA/EIA-568-B.1.
  - 2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
  - 3. Install 110-style IDC termination hardware unless otherwise indicated.
  - 4. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
  - 5. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
  - 6. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
  - 7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
  - 8. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
  - 9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
  - 10. In the communications equipment room, install a 10-foot- long service loop on each end of cable.
  - 11. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
- C. UTP Cable Installation:

1. Comply with TIA/EIA-568-B.2.
2. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.

D. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than **60 inches** apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

E. Group connecting hardware for cables into separate logical fields.

F. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA/EIA-569-A for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
  - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
  - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
  - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
3. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
  - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
  - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
  - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
4. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
5. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

### 3.4 FIRESTOPPING

- A. Comply with requirements in Division 07 Section "Penetration Firestopping."
- B. Comply with TIA/EIA-569-A, Annex A, "Firestopping."
- C. Comply with BICSI TDMM, "Firestopping Systems" Article.

### 3.5 GROUNDING

- A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

- B. Comply with ANSI-J-STD-607-A.

### 3.6 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- B. Cable and Wire Identification:
  - 1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
  - 2. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
    - a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.
    - b. Label each unit and field within distribution racks and frames.
  - 3. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
- C. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA-606-A.
  - 1. Cables use flexible vinyl or polyester that flex as cables are bent.

### 3.7 FIELD QUALITY CONTROL

- A. Tests and Inspections:
  - 1. Visually inspect UTP cable jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-B.1.
  - 2. Visually confirm Category 6, marking of outlets, cover plates, outlet/connectors, and patch panels.
  - 3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
  - 4. UTP Performance Tests:
    - a. Test for each outlet and. Perform the following tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.2:
      - 1) Wire map.
      - 2) Length (physical vs. electrical, and length requirements).
      - 3) Insertion loss.
      - 4) Near-end crosstalk (NEXT) loss.
      - 5) Power sum near-end crosstalk (PSNEXT) loss.
      - 6) Equal-level far-end crosstalk (ELFEXT).

- 7) Power sum equal-level far-end crosstalk (PSELFEXT).
- 8) Return loss.
- 9) Propagation delay.
- 10) Delay skew.

- B. Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.
- C. Prepare test and inspection reports.

END OF SECTION 271500

## **SECTION 275116 PUBLIC ADDRESS SYSTEM**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. Section Includes:
  - 1. Amplifiers.
  - 2. Speaker.
  - 3. Speaker Cable.

#### **1.2 SUBMITTALS**

- A. Product Data: Submit catalog data showing electrical characteristics and connection requirements for each component.
- B. Project Record Documents: Record actual locations of speakers and routing of cable.
- C. Operation and Maintenance Data: Submit instructions for operating system and performing routine troubleshooting procedures.
- D. Warranty documentation.

#### **1.3 QUALITY ASSURANCE**

- A. NEC 70 National Electric Code

#### **1.4 QUALIFICATIONS**

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.
- B. Installer: Service facilities within 100 miles of Project.

#### **1.5 EXISTING CONDITIONS**

- A. Installer shall visit the site to observe any existing conditions that could impact the installation including but not limited to wire routing, speaker mounting, and accessibility. Installer shall account for these existing conditions within their bid.
- B. Intent is to connect the proposed public address system components to the existing public address system for the current Middle School. Existing head-end equipment consisting of a VOIP telephone system and public address system software shall be utilized for new public address system components. New VOIP paging modules required for the building addition shall be fully compatible with existing components and programmed in a similar fashion.

## 1.6 WARRANTY

- A. Furnish a full one-year parts and labor warranty for the system.

## PART 2 - PRODUCTS

### 2.1 SYSTEM DESCRIPTION

- A. Description: Public Address System amplifiers, speakers, and associated cable as shown on the Drawings and described within these specifications.

### 2.2 AMPLIFIERS

- A. General:

1. Distortion: Less than 0.5%
2. Input auxiliary: 47K $\Omega$  200 MV unbalanced
3. Input microphone: 250K $\Omega$  1 MV balanced
4. Input telephone: 10K/600 $\Omega$  100 MV switchable balanced
5. MOH Output: 10K/600 $\Omega$  100 MV switchable balanced
6. Output: 8 $\Omega$  25V 70V
7. Controls Front: Aux volume, mic volume, tel volume, bass, treble, master
8. Controls Rear: Aux gain, MOH level, MIC vox sens, tel vox sens
9. Phantom Power: Aux input
10. Tone Control: +/- 10db at 100 Hz and 10K Hz
11. Vox: Voice activated muting
12. Direct Muting: External contacts
13. Rack Mounting Kit
14. Power Supply 120V
15. Terminations: RCA jacks
16. Watts: See Drawings for wattage requirements
17. Channels: 3

### 2.3 SPEAKERS

1. General

- a. See drawings for speaker schedule

2. Acceptable Manufacturers:

- a. Basis of design is listed on the Drawings. Others speaker manufacturers providing the minimum performance level indicated on the Drawings will be acceptable following Engineer approval.

### 2.4 SPEAKER CABLE

- A. Speaker cable for connection of amplifiers to speakers shall be:



1. Two conductors, stranded, gauge as listed on the Drawings
2. Plenum rated
3. Conforming to NEC 725
4. Insulation Color: White

### **PART 3 - EXECUTION**

#### **3.1 PREPARATION**

- A. Public address system vendor/installer shall visit the site to review all existing conditions that could impact the installation of their system and account for these issues within their bid.
- B. Public address system vendor/installer shall communicate with Owner's IT coordinator to discuss installation requirements, expectations, and scheduling in advance of equipment procurement to ensure coordination with existing IT equipment.

#### **3.2 INSTALLATION**

- A. Installer shall follow all manufacturer published installation, testing, and commissioning procedures and guidelines
- B. Public address system vendor/installer shall provide all necessary hardware and mounting brackets to install speakers and amplifiers. Speakers installed within SAT ceilings shall be provided with tile bridges to support the speaker from the ceiling grid as opposed to the ceiling tile. Cone speakers shall be provided with a steel back box to protect the backside of the speaker. Back box shall include foam disc or other similar method of reducing resonance.
- C. Speakers shall be located in the center of the room to provide the best sound distribution possible to the entire room. Installer shall adjust location of speaker to account for existing equipment and obstructions.
- D. System cabling shall be concealed above SAT ceilings. Where SAT ceilings do not exist, cabling shall be routed in conduit.
- E. Concealed and exposed system cabling shall be routed parallel and/or perpendicular with building lines.
- F. System cabling shall be properly supported and shall not be supported by the ceiling grid or ceiling tiles.
- G. Speakers shall be connected in series (daisy chained). Installing contractor shall provide annotated drawings (as-builts) showing final locations of speakers and cable routing.
- H. Speakers shall be tapped at an output level that will result in speaker volume approximately 10 dB above ambient sound levels when the space is occupied. Contractor shall demonstrate sound levels to Owner and modify tap settings if necessary to achieve Owner's desired sound levels in all spaces. Installing contractor shall note tap setting of each speaker on the as-built drawings.

### 3.3 DEMONSTRATION

- A. Demonstrate and train Owner's personnel on equipment startup, shutdown, and operation.

END OF SECTION 282300

## **SECTION 282300 VIDEO SURVEILLANCE**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. Section Includes:
  - 1. Security cameras.
  - 2. POE switches.
  - 3. Security Camera Cable.

#### **1.2 SUBMITTALS**

- A. Product Data: Submit catalog data showing electrical characteristics and connection requirements for each component.
- B. Shop Drawings: Indicate electrical characteristics and connection requirements, including system wiring diagram.
- C. Project Record Documents: Record actual locations of cameras and routing of cable.
- D. Operation and Maintenance Data: Submit instructions for operating system and performing routine troubleshooting procedures.
- E. Warranty documentation.

#### **1.3 QUALITY ASSURANCE**

- A. NEC 70 National Electric Code
- B. NFPA 731 Standard for the Installation of Premises Security Systems.

#### **1.4 QUALIFICATIONS**

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.
- B. Installer: Authorized installer of manufacturer with service facilities within 100 miles of Project.
- C. Camera system shall not require re-occurring licensing, maintenance, or other fees. A written statement shall be provided with Product Data submittal stating that reoccurring fees are not required.

## 1.5 EXISTING CONDITIONS

- A. Proposed cameras shall be fully compatible and shall be fully integrated into existing video surveillance system within the existing Middle School.
- B. Installer shall visit the site to observe any existing conditions that could impact the installation including but not limited to wire routing, camera mounting, and accessibility. Installer shall account for these existing conditions within their bid.

## 1.6 WARRANTY

- A. Furnish a full one-year parts and labor warranty for the system.
- B. Provide specific equipment warranties as subsequently described in equipment specifications.

# PART 2 - PRODUCTS

## 2.1 SYSTEM DESCRIPTION

- A. Description: Video surveillance at points as indicated on the Drawings.

## 2.2 CAMERAS

- A. Camera Types: See schedule on Drawings for specific camera information.
- B. General:
  - 1. Camera shall be fully compliant with existing digital video recorder.
  - 2. Camera shall be rated for the installed environment (IP-66 rated) (indoor/outdoor).
  - 3. Camera enclosure shall be vandal resistant.
  - 4. Camera enclosure shall be IK-10 impact resistant.
  - 5. Camera shall be capable of streaming 30 fps.
  - 6. Camera shall be ONVIF compliant.
  - 7. PoE capable
  - 8. Two independent IP video streams (dual streaming)
  - 9. Camera shall be capable of day and night operation.
  - 10. Camera shall include integral IR illuminator with minimum 50 ft range.
  - 11. Camera shall include integral motion detection.
  - 12. Camera shall support jpg file image screenshots

## 2.3 NETWORK VIDEO RECORDER

- 1. Existing network video recorder shall be used.

## 2.4 POWER OVER ETHERNET SWITCH

- A. General

1. Dedicated security camera POE switches shall be supplied and installed in new IT racks at locations shown on the Drawings.
  - B. Acceptable Manufacturers: Provided switches shall match District standard switch.
    1. HP Enterprise/Aruba: HPE 1950 JG963A
  - C. Switch Specifications:
    1. Total switch port quantity shall be sufficient to accommodate cameras served by the switch plus a minimum of at least five spare-unused camera ports.
    2. Two additional Gigabit ports for uplink
    3. One SFP+ port
    4. VLAN and QoS capability
    5. Remote capability to power cycles per port
    6. Power Budget shall be sufficient for all cameras served by the switch plus 20% spare capacity. Additional power budget requirements include:
      - a. 16 Port Switch
        - 1) Minimum total power budget of 230 watts
        - 2) Maximum of 30 watts per port
      - b. 24 Port Switch
        - 1) Minimum total power budget of 230 watts
        - 2) Maximum of 30 watts per port
- 2.5 COMMUNICATION CABLE
- A. Communication cable for connection of cameras to the POE switch and POE switches to the network video recorder shall be:
    1. Category 6A
    2. Plenum rated
    3. RJ45 end connections
    4. Conforming to ANSI/TIA-568-C.2 Category 6A
    5. Insulation Color: To be confirmed during shop drawing review from standard insulation colors
  - B. All security camera communication cables in data cabinets must be terminated in new Panduit Minicom modular patch panels using Panduit Minicom CAT6 snap-in modules. Contractor shall provide new patch panels as required to accommodate security camera cables. Contractor shall provide patch cables to connect patch panels and switches.

### **PART 3 - EXECUTION**

#### **3.1 PREPARATION**

- A. Video surveillance system vendor/installer shall visit the site to review all existing conditions that could impact the installation of their system and account for these issues within their bid.
- B. Video surveillance system vendor/installer shall communicate with Owner's IT coordinator to discuss installation requirements, expectations, and scheduling in advance of equipment procurement to ensure coordination with existing IT equipment.

#### **3.2 INSTALLATION**

- A. Installer shall follow all manufacturer published installation, testing, and commissioning procedures and guidelines
- B. Installer shall be factory trained and certified to install, service and maintain equipment
- C. Install camera specific engraved plastic nameplates on each camera. Nameplate identifier shall match camera identification used in digital video recording software.
- D. Video surveillance system vendor/installer shall provide all necessary hardware and mounting brackets to install cameras.
- E. Care shall be utilized to prevent damage to existing surface finishes. Surfaces damaged during project installation. Surface damages caused by the installer shall be repaired to pre-project conditions at no cost to the Owner.
- F. System cabling shall be concealed above SAT ceilings and fished within walls where possible. Where SAT ceilings do not exist, cabling shall be routed in conduit.
- G. Concealed and exposed system cabling shall be routed parallel and/or perpendicular with building lines.
- H. System cabling shall be properly supported and shall not be support by the ceiling grid or ceiling tiles.
- I. Camera shall be aimed and focused by the installing contractor. Coverage area shall be reviewed with Owner following initial camera aiming prior to final camera adjustment.
- J. Videos from cameras shall be integrated into monitoring screens according to Owner input and preferences.

#### **3.3 DEMONSTRATION**

- A. Demonstrate and train Owner's personnel on equipment startup, shutdown, and operation.

END OF SECTION 282300

**SECTION 283111**  
**DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM**

**PART 1 - GENERAL**

**1.1 SUMMARY**

**A. Section Includes:**

1. Fire-alarm control unit.
2. Smoke Detectors
3. Heat Detectors
4. Input Modules
5. Relay Modules
6. Manual fire-alarm boxes.
7. Notification appliances.
8. Magnetic door holders.
9. Wire and Cable.

**1.2 SYSTEM DESCRIPTION**

**A. Project generally consists of the following:**

1. New fire alarm devices in the proposed building addition.
2. Connection of the proposed fire alarm system for the new Middle School wing to the existing fire alarm system in the existing Middle/High School building to the west of the proposed building and to the Intermediate School to the east of the proposed building such that activation of the fire alarm in either of the existing buildings or the proposed buildings will activate the fire alarm notification devices in all three buildings.

**B. Non-coded, UL Listed intelligent analog addressable system, one-way voice communications with multiplexed signal transmission and survivable network nodes**

**C. The system is based upon design using high fidelity speaker to provide voice evacuation instructions. Speakers will also be adjusted in the field by the contractor as necessary for the installation.**

**D. The voice communications system shall have minimum of 12 programmable voice messages and selectable switches at the control panel and LOC/Annunciator for:**

1. Evacuation
2. Soft Lock Down
3. Hard Lock Down
4. Severe Weather
5. Take Shelter
6. Test Message
7. All Clear
- 8-12 Future

- E. Fire alarm contractor shall coordinate with Owner during the shop drawing review process to determine the information to be provided in each voice message.
- F. Provide the following specialty manual stations within the existing Middle School office to automatically activate a pre-recorded message:
  - 1. BLUE Manual Station – Lock Down
  - 2. YELLOW Manual Station – Severe Weather
- G. The fire alarm equipment and installation shall comply with the current provisions of the following latest edition standards and shall be listed for its intended purpose and be compatibility listed to ensure integrity of the complete system.

### 1.3 BUILDING CODES and STANDARDS

- A. National Fire Protection Association (NFPA):
  - 1. NFPA-70 National Electrical Code (NEC)
  - 2. NFPA-72 National Fire Alarm Code
  - 3. NFPA 101 Life Safety Code
  - 4. IBC International Building Code
  - 5. IFC International Fire Code
  - 6. IMC International Mechanical Code
- B. National Electrical Manufacture's Association (NEMA)
- C. Underwriters Laboratories, Inc. (UL)
  - 1. UL-864 Control Units for Fire Protective Signaling Systems (9<sup>th</sup> Edition)
  - 2. UL-268 Smoke Detector for Fire Protective Signaling Systems
  - 3. UL-217 Smoke Detectors for Single and Multiple Station
  - 4. UL-521 Heat Detectors for Fire Protective Signaling Systems
  - 5. UL-464 Audible Signaling Appliances
  - 6. UL-1971 Visual Signaling Appliances
  - 7. UL-38 Manually Actuated Signaling Boxes
  - 8. UL-1481 Power Supplies for Fire Protective Signaling Systems
  - 9. UL 2017 Mass Notification Systems
  - 10. UL 2572 Control and Communication Units for Mass Notification Systems

### 1.4 SUBMITTALS

- A. General Submittal Requirements:
  - 1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
  - 2. Shop Drawings shall be prepared by persons with the following qualifications:
    - a. Trained and certified by manufacturer in fire-alarm system design.
    - b. NICET-certified fire-alarm technician, Level II minimum.
- B. Product Data: For each type of product indicated.



- C. Shop Drawings: For fire-alarm system. Include plans, elevations, sections, details, and attachments to other work.
1. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.
  2. Include voltage drop calculations for notification appliance circuits.
  3. Include battery-size calculations. Batteries shall be upsized 25% from minimum requirements derived from calculations.
  4. Include performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
  5. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
  6. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits from end-to-end. "Home Run" indicators or other non end-to-end wire path designations are not acceptable.
- D. Field quality –control reports.
- E. Demonstration Training Sign-In Sheet
1. Sign in sheet with all attendee's signature from demonstration training for Owner
- F. Operation and Maintenance Data: For fire-alarm systems and components. Provide (3) hard copies in separate 3-ring binders and an electronic copy. Include the following:
1. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA72.
  2. Provide "Record of Completion Documents" according to NFPA72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.
  3. Record copy of site-specific software database file, hardcopy printout and CD, with password for delivery to the owner. Proprietary system/service companies will not be acceptable.
  4. Provide "Maintenance, Inspection and Testing Records" according to NFPA72 article of the same name and include the following:
    - a. Frequency of testing of installed components.
    - b. Frequency of inspection of installed components.
    - c. Requirements and recommendations related to results of maintenance.
  5. Manufacturer's required maintenance related to system warranty requirements.
  6. Abbreviated operating instructions for mounting at fire-alarm control unit.

## 1.5 SEQUENCING AND SCHEDULING

- A. Existing fire alarm systems with the existing Middle/High School and the Intermediate School shall be fully operational whenever students and/or faculty are present in the building. Fire alarm outages to facilitate integration with new fire alarm system shall be coordinated with the Owner and cannot occur when the building is occupied by students or teachers.

## 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
- B. Source Limitations for Fire-Alarm System and Components: Obtain fire-alarm system from single source from single manufacturer.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Federal Signal Corporation.
  - 2. Fire Lite Alarms; a Honeywell company.
  - 3. NOTIFIER; a Honeywell company.
  - 4. Siemens Building Technologies, Inc.; Fire Safety Division.
  - 5. Silent Knight; a Honeywell company.
  - 6. SimplexGrinnell LP; a Tyco International company.
- B. The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approvals agency for use as part of a protected premises protective signaling fire alarm system. The authorized representative of the manufacturer of the major equipment, such as control panels, shall be responsible for the satisfactory installation of the complete system.
- C. The Contractor shall provide, from the acceptable manufacturer's current product lines, equipment and components, which comply, with the requirements of these Specifications. Equipment or components, which do not provide the performance and features, required by these specifications are not acceptable, regardless of manufacturer.

### 2.2 SYSTEMS OPERATIONAL DESCRIPTION

- A. Mass Notification initiated event shall override any event and take the highest system priority.
- B. Fire-alarm signal initiation shall be by one or more of the following devices:
  - 1. Manual stations.
  - 2. Heat detectors.
  - 3. Smoke detectors.
  - 4. Automatic sprinkler system water flow.
- C. Fire-alarm signal shall initiate the following actions:
  - 1. Activate multiple channel pre-recorded voice messages followed by temporal tone.
  - 2. Continuously operate alarm notification appliances.
  - 3. Identify alarm at fire-alarm control unit and remote annunciators.
  - 4. Transmit an alarm signal to the remote alarm receiving station.

5. Release fire and smoke doors held open by magnetic door holders.
6. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
7. Activate emergency lighting control.

D. Supervisory signal initiation shall be by one or more of the following devices and actions:

1. Valve supervisory switch.

E. System trouble signal initiation shall be by one or more of the following devices and actions:

1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of primary power at fire-alarm control unit.
4. Ground or a single break in fire-alarm control unit internal circuits.
5. Abnormal ac voltage at fire-alarm control unit.
6. Break in standby battery circuitry.
7. Failure of battery charging.
8. Abnormal position of any switch at fire-alarm control unit or annunciator.

F. System Trouble and Supervisory Signal Actions: Initiate notification appliance and annunciate at fire-alarm control unit and remote annunciators.

## 2.3 FIRE-ALARM CONTROL UNIT

A. The main control panel or remote control panel(s) shall be a multi-processor based networked system designed specifically for detection, and one-way emergency audio communications applications. The control panel(s) shall be listed and approved for the application under the standard(s) as listed.

B. The control panel(s) shall include all required hardware, software and site-specific system programming to provide a complete and operational system. The control panel(s) shall be designed such that interactions between any application can be configured, and modified using software provided by a single supplier. The control panel operational priority shall assure that life safety takes precedence among the activities coordinated by the control panel.

C. The network of control panels shall include the following features.

1. Each control panel (network node) shall have an LCD display with common controls. The display shall be configurable to display the status of any and all combinations of alarm, supervisory, trouble, monitor, or group event messages.
2. From each LCD display on the system shall be capable of being programmed for control functions of any node or the entire network. The LCD display shall reside on the network as a node and continue to operate with fault on the network. An LCD can be programmed to be only operation when a node is operational in stand-alone mode, with a network fault.
3. Supervision of system components, wiring, initiating devices and software shall be provided by the control panel. Failure or fault of system component or wiring shall be indicated by type and location on the LCD display. Software and processor operation shall be independently monitored for failure. The system shall provide fail-safe operation, with multiple-levels of system operation.
4. Shall be capable of Speaker Volume Control. The Supervised Volume Control will allow manual volume setting for telephone paging and background music for a specific speaker or speaker zone.

5. Shall be capable of independent paging for at least (5) distinct paging zones. The five paging zones shall be as follows:
    - a. New Middle School Wing
    - b. Future
    - c. Future
    - d. Future
    - e. Future
  6. Shall be capable of secure access to the Voice Evacuation/Mass Notification panel via cell phone or other remote telephone.
- D. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, monitor, trouble and component status messages and control menu.
1. The common control switches and with corresponding LEDs provided as minimum will be; Reset Alarm Silence, Panel Silence, and Drill. It shall be able to add additional switches/LEDs as required.
  2. Provide an internal audible signal with different programmable patterns to distinguish between alarm, supervisory, trouble and monitor conditions.
- E. Audio One-Way Voice Communications
1. The voice communication system shall be single channel audio evacuation systems, to allow the ability to have simultaneous announcements/paging.
  2. The system custom digital voice message shall provide a minimum of 2 minutes and be created as a .wav file format.
- F. Provide an Emergency Voice Communication System with the following design features:
1. An audio control unit with Microphone for Paging.
  2. Provide 2-position switch for manually activate pre-recorded voice messages, with "Message Name" positions identified and one LED status indicators, one red. Provide minimum of 12 selector switches.
  3. Provide 2-position switch for manually activate audio paging zones with "Paging Zone Name" positions identified and one LED status indicators, one red. Provide minimum of 12 selector switches.
  4. Locate audio control unit within existing Middle School Office.
- G. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions
- H. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change to alternate settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and print out the final adjusted values on system printer.
- I. Digital Alarm Communicator Transmitter: The system shall have an integrated off premise communications capability using a digital alarm communications transmitter (DACT) for sending

system events to multiple central monitoring station (CMS) receivers. The system shall provide the CMS(s) with point identification of system events using 4/2, 3/1, Contact ID or SIA DCS protocols. The dialer shall have the capability to support up to 255 individual accounts and to send account information to eight (8) different receivers, each having a primary and secondary telephone access number. System events shall be capable of being directed to one or more receivers depending on event type or location as specified by the system designed. In the event of a panel CPU failure during a fire alarm condition, the DACT degraded mode shall transmit a general fire alarm signal to the CMS.

1. Digital data transmission shall include the following (Contact ID)

- a. Address of the alarm-initiating device.
- b. Loss of ac supply or loss of power.
- c. Low battery.
- d. Abnormal test signal.
- e. Communication bus failure

- J. Secondary Power: Shall provide 24 hours supervisory and 15 minutes of alarm with batteries, automatic battery charger, and automatic transfer switch.

2.4 SYSTEM SMOKE DETECTORS

A. General Requirements for System Smoke Detectors

1. Comply with UL 268; operating at 24-V dc, nominal.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
3. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
4. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
5. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status.
6. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.
7. Rate-of-rise temperature characteristic shall be selectable at fire-alarm control unit for 15 or 20 deg F per minute.
8. Fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg F.
9. Provide multiple levels of detection sensitivity for each sensor.
10. Device Replacement: The system shall allow for changing of detector types for service replacement purposes without the need to reprogram the system. The replacement detector type shall automatically continue to operate with the same programmed sensitivity levels and functions as the detector it replaced. System shall display an off-normal condition until the proper detector type has been installed or change in the application program profile has been made.

B. Intelligent Photoelectric Detector

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.

2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
3. Primary status.
4. Device type.
5. Present average value.
6. Present sensitivity selected.
7. Sensor range (normal, dirty, etc.).

## 2.5 HEAT DETECTORS

- A. General Requirements for Heat Detectors: Comply with UL 521.
- B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F or a rate of rise that exceeds 15 deg F per minute unless otherwise indicated.
  1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
  2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

## 2.6 INTELLIGENT MODULES

- A. Intelligent Input Module. The Input Module shall provide one or two supervised Class B input circuit capable of a minimum of 4 personalities, each with a distinct operation. The single input module shall support the following circuit types:
  1. Normally-Open Alarm Latching (Manual Stations, Heat Detectors, etc.)
  2. Normally-Open Alarm Delayed Latching (Waterflow Switches)
  3. Normally-Open Active Non-Latching (Monitor, Fans, Dampers, Doors, etc.)
  4. Normally-Open Active Latching (Supervisory, Tamper Switches)
- B. Intelligent Relay Module. Provide addressable control relay circuit modules shall provide one (1) form C dry relay contacts rated at 120 VAC @ 1 amps (or as required) to control external appliances or equipment. The position of the relay contact shall be confirmed by the system firmware.

## 2.7 MANUAL FIRE-ALARM BOXES

- A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
  1. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
  2. The manual pull station will have an intelligent module integral of the unit.
  3. Station Reset: key operated switch shall match the control panel key.
  4. Manual pull stations that initiated an alarm condition by opening the unit are not acceptable.

- B. Manual Blue – LOCK DOWN station: Station shall be finished in Blue body with white lettering “LOCK-DOWN” and shall have red momentary illuminated mushroom button. Unit shall have clear cover to prevent accidental activation.
- C. Manual Yellow – SEVERE WEATHER station: Station shall be finished in Yellow body with white lettering “SEVERE WEATHER” and shall have red momentary illuminated mushroom button. Unit shall have clear cover to prevent accidental activation.

## 2.8 NOTIFICATION APPLIANCES

- A. All appliances shall be compatible with Fire Alarm Control Panel and application of the appliances shall be done in accordance with the manufacturers' instructions.
- B. All appliances shall be wall or ceiling mounted white body and shall be UL listed Fire Protective Service.
- C. Notification Appliances – Visual
  - 1. Provide clear lens strobes that provide a smooth light distribution pattern field selectable candela 15 cd, 30 cd, 75 cd, and 110 cd flash output rating, UL1971 listed with in-out screw terminals shall be provided for wiring. The strobe (15, 30, 75, 110) candela rating shall be view from the side window to verify the setting. All strobes shall be synchronization to within 10 milliseconds for an indefinite period shall not require the use of separately installed remote synch modules. The strobes shall mount to one-gang electrical box.
  - 2. High candela clear lens strobes that provide field selectable candela 95cd, 115cd, 150cd and 177cd flash output rating, UL1971 listed with in-out screw terminals shall be provided for wiring.
- D. Notification Appliance – High Fidelity Speaker
  - 1. Ceiling mounted, 2'x2' ceiling tile replacement lay-in speak. UL listed as Fire Signaling Device loudspeaker. Loudspeaker cone shall be constructed of molded paper fiber with approved fire retardant treatment.
  - 2. The rear of the speakers shall be completely sealed protecting the cone during and after installation. Speakers shall provide at least four power taps (1/4w, 1w, 2w, and 4w) for use with 70V systems.
  - 3. High Fidelity Speaker listed frequency response of 60 to 12,000 Hz
- E. Trumpet Type Loudspeaker
  - 1. Provide a trumpet speaker at the locations shown on the drawings. The trumpet speaker shall be able to operate within any ambient temperature environment ranging from 66°C (150°F) to -35°C (-30°F), with weather-resistant unit shall be constructed of heavy-gauge treat aluminum. Model shall be a double re-entrant type with 15 watts RMS audio power rating compression driver producing a UL-rated sound pressure level of 102dB measured at 15 watts, 10ft. (3dB increment rating) within a frequency range of 400 Hz to 4 kHz. Impedance shall be 8 ohms and sound dispersion 70°. Power taps shall be available at .9, 1.8, 3.8, 7.5, 15 watts for 70V line. Trumpet loudspeaker assembly shall be furnished with mounting bracket allowing adjustment on either a vertical or horizontal plane with a single locking pin and including provisions for mounting, banding, or strapping. Wiring terminals for amplifier output shall be fully enclosed and a vandal-resistant adapter cover shall provide connection facilities for cable or conduit. Unit shall be finished in either gray

baked epoxy or red baked epoxy. Color shall be verified with Owner prior to ordering and installation.

## 2.9 MAGNETIC DOOR HOLDERS

- A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.
  - 1. Electromagnet: Requires no more than 3 W to develop 25-lbf holding force.
  - 2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
  - 3. Rating: 120-V ac, 24-V ac or dc.
- B. Coordinate rough-in location with door hardware provided. Location of door holders shown on Drawings should be adjusted as required.

## 2.10 WIRE AND CABLE

- A. General: Cable jacket color shall be red.
- B. Signaling Line Circuits – Network Data: Twisted pair, not less than No. 18 AWG or as recommended by the manufacturer.
- C. Signaling Line Circuits – Intelligent Loop: Non-Twisted pair, not less than No. 16 AWG or as recommended by the manufacturer.
  - 1. Circuit Integrity Cable: Provide as required to meet NFPA or Local Code requirements.
  - 2. CI Cable shall meet article 760, power limited fire alarm service.
- D. Notification Appliance Circuits –
  - 1. Audio: Twisted pair, not less than No. 16 AWG or as recommended by the manufacturer.
  - 2. Visual. Non-Twisted pair, not less than No. 12 AWG or as recommended by the manufacturer.

## PART 3 - EXECUTION

### 3.1 EQUIPMENT INSTALLATION

- A. Comply with NFPA 72 and NEC Article 760 for installation of fire-alarm equipment.
- B. Smoke- or Heat-Detector Spacing:
  - 1. HVAC: Locate detectors not closer than 5 feet from air-supply diffuser or return-air opening.
  - 2. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture.
- C. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct.



- D. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.
- E. Fire-Alarm Control Unit: Surface mounted, with tops of cabinets not more than 72 inches above the finished floor.
- F. Annunciator: Install with top of panel not more than 56 inches above the finished floor.

### 3.2 CONNECTIONS

- A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Division 8 Section "Door Hardware." Connect hardware and devices to fire-alarm system.
  - 1. Verify that hardware and devices are NRTL listed for use with fire-alarm system in this Section before making connections.
- B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 3 feet from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
  - 1. Alarm-initiating connection to activate emergency lighting control.
  - 2. Supervisory connections at valve supervisory switches.

### 3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- B. Install framed instructions in a location visible from fire-alarm control unit.

### 3.4 GROUNDING

- A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100.

### 3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
  - 1. Visual Inspection: Conduct visual inspection prior to testing.

- a. Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter.
    - b. Comply with "Visual Inspection Frequencies" Table in the "Inspection" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
  2. System Testing: Comply with "Test Methods" Table in the "Testing" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
  3. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
- C. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
- D. Fire-alarm system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.
- 3.6 DEMONSTRATION
- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION 283111

## **SECTION 311000 SITE CLEARING**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. This Section includes the following:
  - 1. Protecting existing trees, shrubs, groundcovers, plants and grass to remain.
  - 2. Removing existing trees, shrubs, groundcovers, plants and grass.
  - 3. Clearing and grubbing.
  - 4. Stripping and stockpiling topsoil.
  - 5. Removing above- and below-grade site improvements.
  - 6. Disconnecting and capping or sealing site utilities.
  - 7. Temporary erosion and sedimentation control measures.

#### **1.2 MATERIAL OWNERSHIP**

- A. Except for stripped topsoil or other materials indicated to remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

#### **1.3 PROJECT CONDITIONS**

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
  - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
  - 2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
- B. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.
- C. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.
- D. Do not commence site clearing operations until temporary erosion and sedimentation control measures are in place.

### **PART 2 - PRODUCTS**

#### **2.1 SOIL MATERIALS**

- A. Satisfactory Soil Materials: Requirements for satisfactory soil materials are specified in 312300 Excavation and Fill.

1. Obtain approved borrow soil materials off-site when satisfactory soil materials are not available on-site.

### **PART 3 - EXECUTION**

#### **3.1 PREPARATION**

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Locate and clearly flag trees and vegetation to remain or to be relocated.
- C. Protect existing site improvements to remain from damage during construction.
  1. Restore damaged improvements to their original condition, as acceptable to Owner.

#### **3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL**

- A. Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction.
- B. Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
- C. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

#### **3.3 TREE PROTECTION**

- A. Erect and maintain temporary fencing around tree protection zones before starting site clearing. Remove fence when construction is complete.
- B. Do not excavate within tree protection zones, unless otherwise indicated.
- C. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in a manner approved by Architect/Engineer.

#### **3.4 UTILITIES**

- A. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed.
  1. Arrange with utility companies to shut off indicated utilities.
- B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect/Engineer not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect/Engineer's written permission.

### 3.5 CLEARING AND GRUBBING

- A. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

### 3.6 TOPSOIL STRIPPING

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.
- C. Stockpile topsoil materials away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust.

### 3.7 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.

### 3.8 DISPOSAL

- A. Disposal: Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.
1. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities.

END OF SECTION 311000

## SECTION 312300 EXCAVATION AND FILL

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Excavate, fill, compact, and grade the site to the elevations shown on the Drawings, as specified herein, and as needed to meet the requirements of the construction shown in the Contract Documents.
- B. Related work:
  - 1. Documents affecting work of this Section include, but are not necessarily limited to, General Conditions, Supplementary Conditions, and Sections in Division 1 of these Specifications.
  - 2. Information Available to Bidders: Geotechnical Investigation report; bore hole locations and findings of subsurface materials, is attached for reference only.

#### 1.2 QUALITY ASSURANCE

- A. Use equipment adequate in size, capacity, and numbers to accomplish the work in a timely manner.
- B. Perform excavation and embankment work in compliance with applicable rules and regulations of IEPA and OSHA.
- C. Perform Field Quality Controls Testing as specified herein.

### PART 2 - PRODUCTS

#### 2.1 TOPSOIL

- A. Topsoil shall consist of friable, fertile soil of a loamy character. Use suitable topsoil of uniform quality, free from hard clods, roots, sod, stiff clay, hard pan, stones larger than 1 inch (1/2 inch for turfgrass seeding), lime cement, ash, slag, concrete, tar residue, tarred paper, boards, chips, sticks, or any undesirable material.
- B. Use on-site topsoil from sources within the project limits, unless compost-amended or off-site topsoil is specified.
  - 1. **On-site Topsoil:** On-site topsoil material is material excavated from the top 12 inches of the site. Use of on-site topsoil material is subject to the Engineer's approval.
  - 2. **Compost-amended On-site Topsoil:** Amend low-quality on-site topsoil, not meeting the requirements specified for off-site topsoil, with a minimum of 1 inch of compost for every 3 inches of topsoil. Use compost meeting the requirements of mulch for pneumatic seeding in Section 329219 "Seeding".

- 2.2 **Off-site Topsoil:** Contains at least 3% organic matter, according to ASTM D 2974, has a high degree of fertility, is free of herbicides that prohibit plant growth, has a pH level between 5.5 and 7.5, and meets the following mechanical analysis of at least 90 percent must pass the No. 10 sieve. The Engineer will approve the source of off-site topsoil. Surface soils from ditch bottoms, drained ponds, and eroded areas, or soils that are supporting growth of noxious weeds or other undesirable vegetation, will not be accepted. The Engineer will determine if testing is necessary. The Contractor will be responsible for payment of the testing if the off-site topsoil does not meet the above requirements. If the testing verifies the off-site topsoil does meet the above requirements, payment for the testing will be the responsibility of the Jurisdiction.

2.3 SOIL MATERIALS

A. General embankment and fill materials:

1. Predominately granular or non-expansive soils, free from organic matter and deleterious substances, containing no rocks over 3" in greatest dimension and having a minimum Standard Proctor Density of not less than 100 lbs/cu ft.
2. Material is subject to the approval of the A/E, and may be removed from onsite excavations or imported from off-site borrow areas.
3. The upper 12" of fill or embankment shall not have rocks greater than 1" in dimension.
4. For soils to be placed below water, use clean granular material.

B. Structure embankment and fill materials:

1. In addition to the General embankment requirements, soils placed beneath and within 10 feet structures or pavements shall have the following the requirements:
  - a. Cohesive soils must meet all of the following:
    - 1) Liquid limit of less than 40% and a plasticity index greater than 10 and less than or equal to 20%.
    - 2) Density of 110 pcf or greater according to ASTM D 698 or AASHTO T 99 (Standard Proctor Density).
  - b. Granular soils must meet all of the following:
    - 1) Density of 110 pcf or greater according to ASTM D 698 or AASHTO T 99 (Standard Proctor Density).
    - 2) no more than 20% or less of fines passing the 200 sieve
    - 3) Plasticity index of 3 or less
  - c. Drainage Layers:
    - 1) ¾" clean aggregate for drainage.
  - d. Crushed stone, crushed PCC, crushed composite pavement, or RAP; mixtures of gravel, sand, and soil; or uniformly-blended combinations of the above; as approved by the Engineer.
2. Subgrade Treatment (if necessary):
  - a. Cement: Meet the requirements of AASHTO M 85 for portland cement.

- b. Fly ash: Provide Class C meeting the requirements of ASTM C 618 with a minimum of 22% CaO; the Loss of Ignition requirements in Table 1 will not apply. Approval of source required.
- c. Lime: Hydrated lime should meet requirements of ASTM C 207, Type N or AASHTO M 216, and others.

C. Geotextile Materials:

- 1. Geotextile Fabric: Consisting of woven or non-woven filaments of polypropylene, polyester or polyethylene meeting the following minimums:
  - a. Weight (oz/sy): 4.
  - b. Grab tensile Strength (lbs): 200 ASTM D 4632.
  - c. Elongation (%): 15 ASTM D 4632.
  - d. Trapezoidal Tear Strength (lbs): 75 ASTM D 4533.
- 2. Geogrid, Rectangular: Consisting of integrally-formed grid structure manufactured of a stress-resistant polypropylene material meeting the following minimums:
  - a. Minimum true initial modulus in use (lb/ft): 20,000 ASTM D 6637
  - b. Tensile strength, 2% strain (lb/ft): 380 ASTM D 6637
  - c. Flexural rigidity (mg-cm): 250,000 ASTM D 1388
  - d. Aperture Size (in): 0.5 minimum, 2.0 maximum
- 3. Geogrid, Triangular: punched and drawn polypropylene that is oriented in three substantially equilateral directions meeting the following minimums:
  - a. Tensar TX 140 and/or TX160TX or approved equal.

### PART 3 - EXECUTION

#### 3.1 SURFACE CONDITIONS

- A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

#### 3.2 FINISH ELEVATIONS AND LINES

- A. Finish grading shall be worked to contours or elevations indicated on the drawings. Rocks and other debris unearthed during finish grading operations shall be removed from immediate construction area and disposed of elsewhere on site as approved by Owner and Engineer/Architect.
- B. Final disking, harrowing, raking etc. and other preparations for seeding, sod or landscaping will covered in subsequent specification sections.
- C. The Contractor shall provide field engineering services as required but not limited to:
  - 1. Establish and maintain lines and levels.



2. Structural design of shores, forms, and similar items as part of his/her means and methods of construction.

### 3.3 PROCEDURES

#### A. Utilities:

1. Unless shown to be removed, protect active utility lines shown on the Drawings or otherwise made known to the Contractor prior to excavating. If damaged, repair or replace at no additional cost to the Owner.
2. If active lines are encountered, and are not shown on the Drawings or otherwise made known to the Contractor, promptly take necessary steps to assure that service is not interrupted.
3. If service is interrupted as a result of work under this Section, immediately restore service by repairing the damaged utility at no additional cost to the Owner.
4. Where existing underground utilities are in actual contact with the new work, so that such utilities cannot be replaced as originally found prior to excavation, and where relocation and changes are required, then the work shall be replaced or relocated by "others" at no cost to the Contractor. The Contractor shall so coordinate his work as to allow a reasonable time for such replacement or relocation and in no event shall extra compensation be allowed for such coordination or any reasonable delay occasioned there from. Should it be found necessary or desirable by the Owner for the Contractor to perform the work of replacement or relocation, the Engineer/Architect will issue in writing a field order defining the extent of the additional work and instructing the Contractor to proceed with such construction. Compensation for such work shall be determined as set forth in paragraphs 14 and 17 of the General Conditions.

#### B. Protection of persons and property:

1. Furnish, install and maintain barricades, warning lights, and/or warning tape at open holes and depressions or other potential hazards occurring as part of this Work.
2. Operate warning lights during hours from dusk to dawn each day and as otherwise required.
3. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, washout, and other hazards created by operations under this Section.
4. Provide traffic control items in accordance with the Manual of Uniform Traffic Control Devices (MUTCD), and the requirements of the governmental agency having jurisdiction, when work is being complete on or adjacent to public streets and/or Right-of-ways.

#### C. Dewatering:

1. Remove all water, including rainwater, encountered during trench and substructure work to an approved location by pumps, drains, and other approved methods.
2. Keep excavations and site construction area free from water.

#### D. MDNR Land Disturbance Permit:

1. The project will result in disturbance of one (1) or more acres of land and will require compliance with the National Pollutant Discharge Elimination System (NPDES) Storm Water Permit.
  - a. The Contractor and will be required to certify that he/she understands and will comply with all requirements of the permit.

- b. The Contractor shall be responsible for developing and implementing a storm water pollution prevention plan in accordance with good engineering practice.
- c. The plan shall identify potential sources of pollution, which may be expected to affect the quality of storm water discharges. In addition, the plan shall describe and ensure the implementation of practices which will be used to reduce the pollutants in the storm water discharges associated with the project. A copy of the permit form and a sample plan if not a part of these specifications can be obtained at the A/E's office.

### 3.4 TOPSOIL STRIPPING

#### A. Stripping and Salvaging Topsoil:

1. Mow all weeds, grass, and growing crops or other herbaceous vegetation close to the ground and remove from the site. Shred sod by shallow plowing or blading and thorough disking. Thoroughly shred to allow the soil to be easily spread in a thin layer over areas to be covered. If allowed by the Engineer, herbicides may be applied, and vegetation may be incorporated into the topsoil.
2. Remove an adequate amount of topsoil from the upper 8 inches of existing on-site topsoil to allow finish grading with a finished grade of 8 inches of salvaged or amended topsoil. The topsoil may be moved directly to an area where it is to be used, or may be stockpiled for future use.

#### B. Preparation for Topsoil Placement:

1. Finish excavation and embankment work according to the specified grades and cross cross-sections; grade and slope all surfaces to drain away from buildings and prevent ponding. Conform to the grading plan within  $\pm 2$  inches.
2. Loosen surface to a minimum depth of 4 inches to reduce compaction.

#### C. Topsoil Spreading and Finish Grading:

1. Place the topsoil after all grading and trenching activities in the area have been completed.
2. Place topsoil at least 8 inches deep; smooth and finished grade according to the contract documents. If topsoil is being amended with compost, thoroughly blend compost with on onsite topsoil at the rate specified
3. After finish grading the topsoil, remove clods, lumps, roots, litter, other undesirable material, or stones larger than 1 inch (1/2 inch for turfgrass).
4. Excess topsoil shall be removed offsite or incorporated into the embankment, if acceptable, in areas not requiring structural fill.

### 3.5 EXCAVATING

#### A. Perform excavation within the project limits to the lines, grades, and elevations indicated and specified herein.

#### B. Excavated Materials:

1. Satisfactory materials shall be used for fill or embankments within the project limits.
2. Unsatisfactory materials shall be excavated to a depth below grade sufficient to provide a suitable subgrade support, and fill and compact with satisfactory materials.

C. Surplus materials:

1. Dispose of unsatisfactory excavated materials, and surplus excavated material, offsite at disposal areas arranged and paid for by the Contractor.

D. Drainage:

1. Provide temporary drainage facilities to prevent damage to public or private interests when necessary to interrupt natural drainage or flow of artificial drains.
2. Excavate and fill in a manner and sequence that will provide proper drainage at all times.
3. Restore original drainage as soon as work allows.

E. Off-site Borrow:

1. Obtain material required for fill or embankment in excess of that produced within the grading limits of the project from borrow areas selected and paid for by the Contractor and approved by the Owner or his/her representative. The Contractor shall obtain written agreements from the property owners for the removal of the materials.

F. Stability of Excavations:

1. Perform excavations in accordance with OSHA excavating rules and regulations.
2. Slope sides or shore and brace where sloping is not possible because of space restrictions of stability of the materials being excavated.
3. Maintain sides and slopes of excavations in a safe condition until completion of filling.

G. Excavating for Structures:

1. Excavate to elevations and dimensions shown for building pad within a tolerance of 0.05ft., and extending a sufficient distance from footings and foundations to permit placing and removing concrete formwork, installation of services and for inspection.
2. Excavation for footings and foundations shall not disturb the bottom of the excavation:
  - a. Excavate and trim with hand tools as necessary to final grade just before concrete is placed.

H. Excavating for pavements:

1. Excavate subgrade under pavements to within 0.05 ft of the proposed subgrade.
2. Prepare subgrade as specified herein.

I. Cold weather protection:

1. Protect excavation surfaces from freezing when an atmospheric temperature is less than 35 degrees F.

3.6 EMBANKMENT

A. Fill excavations as promptly as progress of the Work permits, but not until:

1. Acceptance of construction below finish grade.
2. Concrete formwork is removed.
3. Shoring and bracing are removed, and voids have been backfilled with satisfactory materials.

4. Trash and debris have been removed.

B. Subgrade Preparation:

1. Remove vegetation, topsoil, obstructions, and deleterious materials from the ground surface prior to placement of embankment per Section 3.4 of this specification.
2. Disk excavated area to a depth of 8", unless sand or aggregate. Proof roll and prepare the surface per Section 3.8-D of this specification. Unsuitable material or material not achieving the specified stability, density and moisture requirements after three consecutive good drying days of moisture conditioning and compaction, consisting of at least two processing's utilizing discs or tillers, shall be removed and/or replaced, or shall be further treated per instructions of the soils engineer. Additional work or materials required after the three day conditioning period to stabilize the material, when approved in writing by the Owner or his/her representative, shall be performed and paid for in accordance with the General Conditions.

C. Subgrade Treatment:

1. Lime, Cement, or Fly Ash:
  - a. Incorporate the subgrade treatment material uniformly during subgrade preparation to the depth and rate specified in the contract documents.
  - b. Place subgrade treatment in the areas as specified or as directed by the Engineer.
2. Geogrid or Geotextiles:
  - a. Install according to manufacturer's recommendations, on top of the prepared subgrade.
  - b. Geogrid shall only be utilized when the aggregate base thickness will have a minimum of six (6) inches thick in order to prevent it from popping through the aggregate base. Minimum lap shall be 12" and minimum sewn lap shall be 4" or as specified by the manufacturer.
  - c. Place subgrade treatment in the areas as specified or as directed by the Engineer.

D. Placing and compacting:

1. Place fill materials in layers not more than 8" in loose depth, unless otherwise approved by the A/E.
2. Before compacting, moisten or aerate each layer as necessary to provide the specified moisture content.
3. Compact each layer to required percentage of maximum density for the area.
4. Do not place backfill or fill material on surfaces that are muddy, frozen, or containing frost or ice.
5. Place backfill and fill materials evenly adjacent to structures, to required elevations.
6. Prevent wedging action of backfill against structures by carrying the material uniformly around the structures to approximately the same elevation in each lift.
7. The building embankment shall be constructed at minimum 5 feet beyond the proposed building line and pending approval of the compacted fill, shall be cut back at a 1:1 slope extending from the top of the proposed footing to 4 feet inside the building wall.
8. Placement of granular drainage material beneath the floor slab will be completed by the Building Contractor.

### 3.7 GRADING

#### A. General:

1. Uniformly grade the areas within project limits under this Section, including adjacent transition areas.
2. Finished surfaces within specified tolerance.
3. Compact with uniform levels or slopes between points where elevations are shown on the Drawings, or between such points and existing grades.
4. Where a change of slope is indicated on the Drawings, construct a rolled transition section having a minimum radius of approximately 8'-0", unless adjacent construction will not permit such a transition, or if such a transition defeats positive control of drainage.

#### B. Grading inside building lines:

1. Provide drainage away from structures during construction of the embankments to prevent ponding.
2. Finish surface within 0.05 foot of the proposed subbase elevation.

#### C. Grading outside building lines:

1. Provide drainage in areas adjacent to buildings away from the structures, and to prevent ponding.
2. Finish areas under walks and pavements to within 0.05 ft above or below the required subgrade elevation.

### 3.8 COMPACTING

- #### A. Control material compaction during construction to provide the minimum Standard Proctor Density (SPD) specified, within moisture requirements, for each area as determined according to (ASTM D 698).

- #### B. Provide not less than the following minimum densities for layer or lift of material placed:

Compaction Recommendation Summary – Building Floor Slabs

| Description                     | ASTM D 698 | Moisture Content from Optimum |
|---------------------------------|------------|-------------------------------|
| Building Subgrades (Top 12")    | 95%+       | 0% to +5%                     |
| Structural Fill/LVC             | 95%+       | -2% to +4%                    |
| Footing Overexcavation Backfill | 98%+       | ±2%                           |

Recommendation Pavement Section Summary

| Description                  | ASTM D 698 | Moisture Content from Optimum |
|------------------------------|------------|-------------------------------|
| Structural Fill for Pavement | 95%+       | -2% to +4%                    |
| Pavement Subbase (Top 12")   | 98%+       | ±2%                           |
| Pavement Base (Aggregate)    | 100%+      | ±2%                           |

C. Moisture control:

1. Moisture content for compaction purposes shall be within the ranges noted above as established by ASTM D 698.
2. Existing ground surface or embankment layer of material, if necessary, shall be moisture-conditioned before compacting by:
  - a. For material below specified moisture parameters, uniformly apply water to surface of the material and incorporate with a disk or tiller.
  - b. For material above the specified moisture parameters, air dry with disks and tillers or replaced with acceptable onsite soils at the Contractors expense. If moisture reduction is unable to be achieved after multiple attempts, due to temperature or excessive weather conditions the A/E may approve another method.
3. Process material to provide uniform moisture and clod reduction throughout.
4. Unsuitable material removed due to high moisture may be spread and allowed to dry until suitable.

D. Proof roll:

1. Prior to placement of granular subbase material on building and pavement areas, the subgrade shall be "proof rolled" with a minimum 25 ton gross vehicle weight (G.V.W.) truck to identify areas of soft or unstable subgrade. Permanent rutting in excess of 1" should be considered failure. Elastic (rebound) movement or rutting in excess of 1" with substantial cracking or substantial lateral movement should be considered failure. Rutting and cracking greater than detailed above is considered "pronounced elasticity." Elastic, rebound, or rolling movement is always associated with excess water in the subgrade system. Failing areas detected by proofrolling should be immediately repaired and retested or removed and replaced with suitable material.

3.9 FIELD QUALITY CONTROL

- A. The Owner shall provide testing services of a soils engineer and/or independent laboratory approved by the Owner.
- B. Upon completion of each test and/or inspection, promptly distribute copies of test or inspection reports to the A/E.
- C. Testing Requirements:
  1. Pentrometer Tests:
    - a. 1 per each spread footing.
    - b. 1 per 25' of lineal footing.
  2. Standard Proctor Density/Moisture (ASTM D 698):
    - a. 1 per the insitu fill material.
    - b. 1 per each source of offsite fill material.
  3. Field density/moisture tests ASTM D 2922 and ASTM D 3017 (nuclear) or ASTM D 1556 (sand cone) and ASTM D 2216 (moisture content):
    - a. Paved Areas: 1 per 5000 sq ft per 8" lift.

b. Building Area: 1 per 2500 sq ft per 8" lift.

4. Liquid Limit and Plasticity Index

a. Building Area: 1 per each source of offsite fill material.

3.10 MAINTENANCE

A. Protection of newly graded areas:

1. Protect newly graded areas from traffic and erosion, and keep free from trash and weeds;
2. Repair and reestablish grades in settled, eroded, and rutted areas to the specified tolerances.

B. Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify the surface, reshape, and compact to the required density prior to further construction.

3.11 CERTIFICATION

A. Upon completion of this portion of the work, and as a condition of its acceptance, deliver to the Owner or his/her site representative a written report from the independent soils engineer or testing laboratory certifying that the compaction requirements have been obtained. Include in the report the soil classification, standard proctor density, optimum moisture content and plasticity index of the onsite and borrow materials used in the areas of embankment,

END OF SECTION 312300

**SECTION 312379**  
**TRENCHING, BACKFILLING, AND COMPACTING**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Trench, backfill, and compact as specified herein and as needed for installation of underground pipelines and utilities associated with the Work.
- B. Related work:
  - 1. Documents affecting work of this Section include, but are not necessarily limited to, General Conditions, Supplementary Conditions, and Division 01 - General Requirements of these Specifications.

**1.2 QUALITY ASSURANCE**

- A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.
- B. Use equipment adequate in size, capacity, and numbers to accomplish the work in a timely manner.
- C. Comply with requirements of governmental agencies having jurisdiction.

**1.3 DELIVERY, STORAGE, AND HANDLING**

- A. Comply with pertinent provisions of Section 016600.

**PART 2 - PRODUCTS**

**2.1 GRANULAR PIPE BEDDING AND COVERING MATERIALS**

- A. Provide well graded, washed, mixture of gravel or crushed stone aggregate free of clay, loam, dirt, calcareous or other foreign matter conforming to the MoDOT "Standard Specifications" Type 5, or the Standard Specifications for Water and Sewer Construction in Illinois, with the following gradation:

| <u>Sieve Size</u> | <u>Percent Passing</u> |
|-------------------|------------------------|
| 1-inch            | 100%                   |
| 3/4-inch          | 84 - 100%              |
| 1/2-inch          | 30 - 60%               |
| No. 4             | 0 - 12%                |
| No. 16            | 0 - 6%                 |

- 1. For flexible thermoplastic pipes including sewer pipes, sewage force mains, and water mains: Comply with ASTM D2321, Class I or II as modified below.



- a. Exclude sharp angular granular materials.
- b. Limit maximum particle size to 1/2-inch.
- c. Do not use Class II materials in wet conditions.

2. For rigid pipes comply with ASTM C12, Bedding Class B.

## 2.2 EXCAVATED BACKFILL MATERIALS

- A. Provide soil materials free from organic matter, rubble, or frozen material, containing no rocks or lumps over 6 inches, and with not more than 15 percent of the rocks or lumps larger than 2-3/8 inches.

## 2.3 GRANULAR BACKFILL

- A. Provide either pit run gravel or granular material:
  1. Pit run gravel: Free from organic matter, cohesionless granular material obtained from natural deposits of sand and gravel, passing 3/4-inch sieve, and not more than 15 percent passing the No. 200 sieve.
  2. Granular material: Use 100 percent crushed stone or gravel complying with the MoDOT "Standard Specifications" Type 5.

## 2.4 FLOWABLE FILL TRENCH BACKFILL MATERIALS

- A. Provide controlled low-strength material (CLSM) where shown on the Drawings.
  1. Provide a portioned cement, fly ash, fine aggregate and water mix.
  2. Comply with MoDOT Standard Specification for material mix design criteria, and testing.
    - a. Acceptable products: Geofill by MixOnSite.
    - b. Or equal.

## 2.5 TEMPORARY PAVEMENT MATERIAL

- A. Provide well graded, 100 percent crushed gravel or crushed stone aggregate free of clay, loam, dirt, calcareous or other foreign matter conforming to the MoDOT "Standard Specifications" Type 5

## 2.6 GEOTECHNICAL FABRIC

- A. Provide geotechnical fabric for separation of granular material and native soil in areas where trench is over-excavated to remove unsuitable materials.
  1. Acceptable manufacturers:
    - a. Mirafi: 160N.
    - b. Synthetic Industries: 601.
    - c. Amaco: 4551.

## 2.7 WATER MAIN REPAIR

- A. Repair water main or water services damaged during construction utilizing products of type and manufacturers as approved by the Owner.
- B. Pipe couplings for joining of sections of cut water main where a section of new pipe is used to replace a broken pipe.
  - 1. Acceptable manufacturers:
    - a. Dresser Style 38.
    - b. Smith-Blair CC-441.
    - c. Or equal.
- C. Repair clamps for broken or cracked pipe and sealing of existing corporation stop opening.
  - 1. Use full-circle single band all stainless steel clamps.
  - 2. Acceptable manufacturers:
    - a. Dresser Style 360.
    - b. Smith-Blair 200 Series.
    - c. Or equal.
  - 3. Replace damaged service corporation stops by installation of full-circle single band all stainless steel clamps, with service outlet, matching manufacturer's and styles used for repair of a cracked pipe.

## 2.8 DRAIN TILE REPLACEMENT

- A. Replacement pipe: New pipe of the same size. Match material or use new PVC SDR-26 pipe per ASTM D3034.
- B. Utilize flexible couplings with stainless steel bands for connecting new pipe to old pipe.
- C. Provide Type 5 aggregate for backfill material.

## PART 3 - EXECUTION

### 3.1 SURFACE CONDITIONS

- A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

### 3.2 GENERAL CONSTRUCTION REQUIREMENTS

- A. Protection of existing facilities:
  - 1. Unless shown to be removed, protect existing structures, conduits, active utility lines and all other facilities shown on the Drawings or otherwise made known to the Contractor. If

- damaged, repair, replace, or restore to a condition equal to or better than the original condition at no additional cost to the Owner.
2. Notify all persons, firms, corporations, or agencies owning or using any existing structures, conduits, or utilities which may be affected by the Work prior to the start of construction.
  3. Make arrangements to locate, maintain, protect, and/or relocate facilities in order to complete the Work.
  4. Make such exploration as is necessary to determine the exact location of underground utilities.
  5. Exercise care during the progress of work in the area to prevent damage to the utilities.
  6. Whenever it becomes necessary to relocate underground gas mains, telephone conduit, or electrical lines or support or relocate utility poles, the utility company involved will make such relocation or provide pole support. Notify the utility company promptly.
  7. Whenever it becomes necessary to relocate water or other pipes or conduits in direct conflict with the proposed pipe (exclusive of culverts) which are not shown on the Drawings, obtain the direction from the Engineer for the relocation. Compensation will be allowed only for such quantities as directed by the Engineer.
  8. Do not block or obstruct sidewalks, streets, and pavements.
  9. Whenever during construction operations any loose material is deposited in the flow line of gutters, drainage structures, or ditches such that the natural flow line of water is obstructed, remove this loose material at the close of each working day. At the conclusion of construction operations, keep all drainage structures and flow lines free from dirt and debris.
  10. Do not obstruct accessibility of fire hydrants.
  11. Maintain access to adjacent areas at all times.

B. Protection of Trees and Shrubs:

1. Protect trees and shrubs from damage.
2. Do not remove trees or shrubs unless indicated on the Drawings or authorized in the field by the Engineer.
3. Where trees which are to remain interfere with normal excavation operations, use the following procedures:
  - a. Prior to excavation, carefully remove trees with trunk diameters of less than 4 inches, shrubs, and other plantings in the way of construction.
  - b. Do not machine excavate within a distance of three trunk diameters or 12 inches (whichever is greater) of any tree, and do not cut roots over 2-inch diameter unless approved by the Engineer.
  - c. Excavate by hand when closer than three tree trunk diameters or 12 inches (whichever is greater).
  - d. Tree tunneling where necessary to be determined by the Engineer.
  - e. Tie back shrubs and tree limbs to prevent loss or damage.
  - f. Prune and seal damaged limbs and branches.
  - g. Provide plank wrappers wired in place to protect tree trunks from being damaged by trench machinery, tractors, or trucks; remove protective planking as soon as practical after work in vicinity has been completed.
  - h. Remove spoil banks from around trees by hand to prevent damage to trunks by construction machinery.
4. Replace trees and shrubs which cannot be protected or are damaged during construction:
  - a. Replant or replace with stock of like character, quality, variety, size, shape, color and condition upon completion of the construction.

- b. Replace 4-inch diameter and larger trees with one 4-inch diameter size tree for each 6" of original tree diameter or fraction thereof.
  - c. Replace trees smaller than 4-inch diameter and shrubs with same kind and type.
  - d. As an option, replant trees smaller than 2-inch diameter or shrubs which are not damaged.
5. Remove and replace trees and shrubs which do not survive in good condition for a period of 18 months after time of planting.

C. Work on private property:

1. Construct work on private property within easements obtained by the Owner as shown on the Drawings.
  - a. The Contractor will be permitted construction privileges within construction easement lines as shown on the Drawings.
  - b. Perform the work in a manner such as to minimize damage to lawns, shrubs, trees and other plantings, driveways, sidewalks, fences, outbuildings, and any other miscellaneous improvements, using proper size and type of equipment.
  - c. The Engineer has the authority to prohibit the use of any equipment which in his judgment is too large or otherwise unsuitable for the conditions of the work on private property.
2. Remove and replace fences, outbuildings and other miscellaneous improvements in the way of construction to the satisfaction of the property owner.
3. When working in cultivated fields or gardens remove original topsoil to a depth of 12 inches prior to excavation, and replace the topsoil to its original depth and grade upon completion of trench backfill.
4. Restore the private property to its original condition or better, free of debris, stones and excess materials.

3.3 TRENCHING

- A. Do not advance trench excavation more than 50 feet ahead of completed pipe installation except as approved by the Engineer.
- B. Provide and maintain sheeting, shoring, and bracing necessary for protection of the Work, adjacent property, and for the safety of personnel.
  1. Remove temporary sheeting and bracing after backfilling to an elevation which will prohibit caving of exposed sidebanks.
  2. Fill voids left by the withdrawal of sheeting with compacted sand.
  3. The Engineer may direct that supports in trenches be cut off at any specific elevation to protect adjacent facilities or property. Compensation for support left in place will be negotiated.
  4. No extra payment will be made for the supports left in place without the direction of the Engineer.
  5. Do not leave supports within 4 feet of the ground or pavement surface in place without the permission of the Engineer.
- C. Provide pumping, bailing, wellpointing, and construct ditches and dikes required to dewater and drain ground water, sewage, or storm water to keep the excavation and site dry for the completion of the Work.

D. Excavation:

1. Excavate by open cut unless otherwise indicated on the Drawings.
2. Excavate trenches to the depths and grades necessary for the pipelines with allowances for bedding material.
  - a. Comply with the following minimum depth of cover unless otherwise noted on the Drawings.
  - b. Water pipelines: 4.5 feet.
  - c. Sewage and sludge pressure piping: 5 feet.
  - d. Air and gas piping: 3 feet.
  - e. Electrical or wiring conduits and cables: 30 inches.
3. Over-excavate organic, soft, spongy, or otherwise unsuitable soils found at or below the bottom of the trench to meet firm subsoil or as directed by the Engineer.
4. Comply with the following maximum trench widths at the top of pipelines:

| Nominal Pipe Sizes<br>(inches) | Trench Widths<br>(inches) |
|--------------------------------|---------------------------|
| 12 or smaller                  | 30                        |
| 14 - 18                        | 36                        |
| 20 - 24                        | 42                        |
| 27 - 30                        | 48                        |
| 33 and larger                  | 1-1/3 times pipe OD       |

5. Where the trench width exceeds the maximum limitations, provide higher strength pipe, or embed or cradle the pipe in concrete to achieve the necessary load factor as determined by the Engineer at no additional cost to the Owner.

3.4 EXCAVATION FOR APPURTENANCES

- A. Excavate for manholes and similar structures to the depths as shown on the Drawings and to a distance sufficient to leave at least 12 inches clear between outer surfaces and the embankment or shoring that may be used to hold and protect the banks.
- B. Over-depth excavation beyond depths indicated on the Drawings that has not been directed will be considered unauthorized. Fill with sand, gravel, or lean concrete as directed by the Engineer, and at no additional cost to the Owner.

3.5 BEDDING AND COVERING OF PIPE

A. General:

1. Bedding is defined as the shaped and tamped material which supports the pipes. Covering is defined as the compacted material which protects and covers the pipes.
2. Provide continuous bedding and covering for underground pipelines, except where concrete encasement, concrete cradles, boring or jacking are indicated.

B. Pipe bedding:

1. Provide compacted granular pipe bedding and covering material with a minimum thickness of 4 inches under pipe barrels and 2 inches under bells.

2. Wherever the trench is over-excavated due to the removal of unsuitable material, refill the excavated area to the bottom of the pipe bedding with material conforming to the MoDOT "Standard Specifications" gradation.
3. Wherever the trench is over-excavated to remove unsuitable material, install geotechnical fabric between native soil and granular material:
  - a. Install fabric to cover bottom and sides of trench to heights as follows:
    - 1) For all flexible pipe and rigid pipe 24-inch and smaller: to envelop entire bedding and covering material and overlap 1-foot at the top.
    - 2) For rigid pipe 27-inch and larger to cover bedding material and from sides of trench to edge of pipe.
    - 3) Where undercut is of a depth that requires more than one piece of fabric to provide envelope, provide sewn seams between sections of fabric.
4. Wherever two or more pipes or conduits are placed in the same trench or excavated area, backfill the trench with granular pipe bedding and covering material to support the uppermost pipe or conduit.
5. Provide sand bedding with a minimum thickness of 3 inches under electrical and wiring conduits and cables.

C. Pipe covering:

1. Following placement of pipe and inspection of joints, provide compacted granular pipe bedding and covering material for the full width of the trench to the following levels unless otherwise shown on the Drawings:
  - a. For pipes sizes 24-inch and smaller, except flexible thermoplastic pipe: To 4 inches above the top of the pipe.
  - b. For pipes sizes 27-inch and larger, except flexible thermoplastic pipe: To the horizontal centerline of the pipe.
  - c. For flexible thermoplastic pipes, including ABS and PVC composite pipe, PVC plastic pipe, and other flexible type pipe: To 12 inches above the top of the pipe.
  - d. If compacted excavated materials are used for backfilling under the pavement as indicated on the Drawings: To 12 inches above the top of the pipe for all pipe sizes.
2. Place granular pipe bedding and covering material in uniform loose layers not exceeding 8 inches thick.
  - a. Compact each layer firmly by ramming or tamping with tools approved by the Engineer in such a manner as not to disturb or injure the pipe to yield a minimum density of 95 percent of maximum dry density as determined according to ASTM D1557 or AASHTO-T180.
3. Where trench is widened by installation of structures or jacking pits, extend bedding and covering materials to total width of excavations.

### 3.6 TRENCH BACKFILLING AND COMPACTING

A. General:

1. Backfill trench from the top of pipe cover to topsoil, paving subgrade, or foundation level.

2. If trenches settle during the period of construction and within the guarantee period of the work, fill trench back to the surrounding grade, and restore the surfaces.
  - B. For trench in lawns, parkways, and other improved areas not subject to vehicular traffic:
    1. Backfill with excavated materials in uniform loose layer not exceeding 12 inches thick.
    2. Compact each layer of trench backfill materials to yield a minimum of 85 percent of maximum dry density as determined according to ASTM D1557 or AASHTO-T180.
  - C. For trench in unimproved areas and cultivated fields:
    1. Backfill with excavated materials.
    2. Provide crowned surface to compensate for settlement.
  - D. For trench in streets, parking areas, driveways, sidewalks, curb and gutter, or within 2 feet of any proposed curb and gutter, sidewalk, or other paved areas:
    1. Backfilling with granular backfill materials:
      - a. Place in uniform loose layer not exceeding 12 inches thick and compact with vibrating roller or equivalent.
      - b. Water jetting may be used in lieu of vibratory compaction when approved by the Engineer.
        - 1) Demonstrate jetting procedures before beginning operation.
        - 2) Place and jet in maximum lift of 6 to 8 feet.
        - 3) Do not place paving until surface settlement has occurred or a minimum of 30 days after jetting.
      - c. Fill the top 12 inches of trenches with temporary pavement material.
    2. Compacting requirements:
      - a. Compact each layer of trench backfill materials to yield a minimum density of 90 percent of maximum dry density as determined according to ASTM D1557 or AASHTO T-180.
      - b. Determine the density of compacted backfill at intervals of not more than 500 feet at locations selected by the Engineer.
      - c. Provide the services of an independent testing laboratory for the density tests complying with the pertinent provisions of Section 014529.
    3. Maintain temporary pavement level with adjoining pavement surfaces until the permanent pavement is placed.
- 3.7 BACKFILL AND BEDDING FOR APPURTENANCES
- A. Provide 3 inches of sand or granular bedding material unless otherwise shown on the Drawings.
  - B. Do not backfill until new concrete has properly cured, and any required tests have been accepted.
  - C. Backfill in lawns and landscaped areas with excavated materials.

- D. Backfill in pavement around manholes, catch basins, inlets, valve vaults, and other structures as directed by the Engineer with special granular backfill materials.

### 3.8 FINISH GRADING

#### A. General:

1. Provide finish grading and filling to achieve the lines and grades.
2. Slope grades to drain away from structures.
3. Replace culverts damaged during the construction with new culverts as specified in Section 334213 of the Specifications.

#### B. Finish grading:

1. Except where mounding over trenches is specified, grade smooth areas of the Work including previously grassed areas that have been disturbed, and adjacent transition areas.
2. Fill and compact depressions from settlement and round tops of embankments and breaks in grade.
3. Protect newly graded areas from traffic and erosion. Repair settlement or washing away that may occur prior to surface restoration and re-establish grades to the required elevations at no additional cost to the Owner.

#### C. Disposal of waste excavated material:

1. Remove unsuitable and surplus excavated materials not used for backfilling from the project site.
2. Do not deposit on public or private property without written permission from property owner or authorized representative of appropriate public agency.

### 3.9 WATER MAIN REPAIR

- A. Whenever existing water mains and water service pipes are damaged during construction, stop the pipe installation work and immediately repair the damaged portion of the existing piping.
- B. Contact the Engineer and Owner immediately to report the location and extent of the damage.
- C. Repair the water main with methods complying with Missouri DNR Standards and any additional requirements required by the Owner.
- D. Utilize only materials of repair as noted in the products section of this specification or as dictated by the Owner.
- E. Where water services have been stripped or pulled from the water main, replace the corporation stop as instructed by the Engineer and Owner, and replace the water service pipe to a point as directed by the Owner.
- F. Comply with disinfection requirements as dictated by the Owner.
- G. Do not cover the repair until work is inspected and approved by Owner.



### 3.10 ROCK EXCAVATION

- A. Rock excavation is classified as excavation requiring blasting or jack hammering to remove solid rock formations such as boulders, concrete, or solid masonry exceeding one cubic yard in volume.
- B. Allowable trench width for open trench excavation:
  - 1. For pipes up to 18 inches ID: 30 inches.
  - 2. For larger pipes: The outside diameter of the pipe plus 8 inches.
  - 3. Pipe bedding: 6 inches below the bottom of the pipe.
  - 4. Manholes and similar structures not requiring formwork: 1-foot outside such structures.
- C. Lay pipelines constructed in trenches in rock to the grades shown on the Drawings on a continuous bed of compacted gravel or crushed stone.
  - 1. Dispose of excavated rock; do not use as backfill.
- D. Blasting:
  - 1. Comply with rules and regulations of authorities having jurisdiction.
    - a. Issue signals of danger before firing a blast.
    - b. Do not blast adjacent to any portion of the completed work unless proper precautions are taken to protect the work.
    - c. Use only persons who are licensed as required by state or local regulations, and who are experienced in the techniques of blasting, to perform blasting operations.
  - 2. Repair or reconstruct structures, pipelines, or other property damaged by blasting operations.

### 3.11 DRAIN TILE REPLACEMENT

- A. Replace all drain tile disturbed or damaged with new pipe of the same size, at same grade and slope, and utilizing flexible couplings for connection to existing pipe.
- B. Indicate location, depth, and size of drain tile on Job Set of plans.
- C. Provide aggregate backfill from bottom of trench to a minimum of 12 inches above new drain pipe.
- D. Inform Engineer immediately when drain tiles are encountered as a part of the trenching operation.
  - 1. Drain tile repair conducted without the observance of the Engineer will not be paid for.

END OF SECTION 312379

## **SECTION 321123 AGGREGATE BASE COURSES**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. Provide aggregate base courses on a prepared subbase where shown on the Drawings, and as specified herein.

#### **1.2 SUBMITTALS**

- A. Comply with pertinent provisions of other Sections
- B. If requested by the Engineer/Architect (A/E), within 15 calendar days after the Contractor has received the Owner's Notice Award, submit:
  - 1. Certifications of material compliance for:
    - a. Aggregate base course
    - b. Geotextile fabric
    - c. Geogrid materials

#### **1.3 REFERENCES**

- A. Standard Specifications for Highway Construction, Current Edition, Missouri Department of Transportation (MoDOT) herein noted as the Standard Specifications.

### **PART 2 - PRODUCTS**

#### **2.1 MATERIALS**

- A. Geotextile Fabric: As specified in Section 312300 Excavation and Fill.
- B. Geogrid Material: As specified in Section 312300 Excavation and Fill.
- C. Aggregate Base Course:
  - 1. MODOT TYPE 5.

### **PART 3 - EXECUTION**

#### **3.1 SUBGRADE PREPARATION**

- A. Subgrade preparation shall be in accordance with Section 3.6 of 312300 Excavation and Fill of these specifications.

### 3.2 GEOTEXTILE FABRIC

- A. Geotextile fabric when specified shall be placed on the prepared subbase prior to placement of the aggregate base course. Fabric of insufficient width or length to fully cover the specified area shall be lapped or sown. Minimum lap shall be 12" and minimum sewn lap shall be 4".
- B. Placement of the base course on the fabric shall be accomplished in a manner as to prevent tearing or shoving of the material. Fabric damaged shall be repaired or replaced prior to placement of the base course.

### 3.3 GEOGRID

- A. Geogrid when specified shall be placed on the prepared subbase prior to placement of the aggregate base course. When geogrid is used for stabilization, the aggregate base thickness shall be a minimum of six (6) inches thick in order to prevent it from popping through the aggregate base. Minimum lap shall be 12" or as specified by the manufacturer.

### 3.4 AGGREGATE PLACEMENT

- A. General: The aggregate shall be uniform in gradation. The base course shall be constructed in layers not more than four (4) inches thick when compacted, except that if tests indicate that the desired results are being obtained, the compacted thickness of any layer may be increased to a maximum of six (6) inches. When placed, it shall be free from segregation and shall require minimum blading or manipulation. Immediately after the material has been placed, it shall be compacted with a tamping roller, a vibratory machine or combination of the two.
- B. Compaction: Before the aggregate is deposited on the subgrade, the aggregate shall contain the amount of moisture required for compaction. The granular material shall be compacted to not less than 98 percent of the Standard Laboratory Density, determined in accordance with ASTM D 698. If test indicate that the base course does not comply with the density requirements, additional wetting, if necessary, and rolling will be required until the density is obtained. Moisture shall be added to the material during compaction only when it is necessary to increase the percentage of moisture to obtain the required density.
- C. Staging: The aggregate base shall initially be placed and compacted to 90% of the design thickness shown on the Drawings. The remaining 10% of the aggregate base and final finishing shall be completed after the curbs and driveways are installed. The final surface shall be within + or - 0.5".
- D. Flatness: Maximum variation of 1/2 inch measured with 10-foot straight edge.

### 3.5 FIELD QUALITY CONTROL

- A. The Owner will provide testing services of a soils engineer and/or independent laboratory for this project.
- B. Upon completion of each test and/or inspection, promptly distribute copies of test or inspection reports to the A/E.
- C. Testing Requirements:

1. Determine moisture-density relationships by ASTM D 698 (Standard Proctor). Perform at least one test for each type of material used.
2. Provide not less 98% of maximum density of material compacted at optimum moisture content for the actual density of each layer of material in place.
3. Field density/moisture tests (ASTM D 6938):
  - a. Aggregate Base: 1 per 5000 sq ft.

END OF SECTION 321123

## SECTION 321217 AGGREGATE SURFACE COURSE

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Provide aggregate surface course where shown on the Drawings, and as specified herein.
- B. Work shall consist of preparing the completed subgrade. It shall include shaping and final compaction of the subgrade material for the construction of the surface course.

#### 1.2 REFERENCES

- A. *Standard Specifications for Highway Construction, 2022*, Missouri Department of Transportation (MODOT) herein noted as the Standard Specifications.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS

- A. Provide materials in accord with referenced Articles in the Standard Specifications.
- B. Aggregate:
  - 1. Section 1007-Type 5

### PART 3 - EXECUTION

#### 3.1 GENERAL

- A. The entire subgrade shall be prepared by removing all vegetation, filling all depressions, and bringing the surface to grade. Soft and unsuitable material that will not compact when rolled or tamped shall be processed as described below or removed, disposed and replaced with suitable material.
- B. The subgrade shall be compacted to 95 percent of standard proctor density.
- C. In cut sections the Contractor shall take the following steps to obtain not less than 95% of the standard proctor density in the subgrade.
  - 1. Step 1 - Cut plan ditches which are to drain the area at least two weeks prior to Step 2
  - 2. Step 2 - Air dry the top 8" of the subgrade. This procedure shall include at least two 8" depth processings utilizing discs or tillers each day for three consecutive days.
  - 3. Step 3 - Recompect the layer processed in Step 2 to achieve the required density or until a roller which has the ability to obtain the density has made at least 9 passes over the area.

- D. If the subgrade does not meet the density requirements after processing, the Engineer shall be notified to determine how the density shall be obtained. Work completed after processing to obtain a satisfactory subgrade density in an area shall be paid for as Extra Work.

### 3.2 AGGREGATE SURFACE

- A. General: The subgrade shall be constructed so that after being compacted, it will conform to the alignment, grade and cross section shown on the plans prior to placement of the Aggregate Surface Course.
- B. The aggregate surface shall be constructed to the thickness shown on the plans. The aggregate shall be placed such that the required amount of material will be deposited uniformly along the central portion of the roadbed and spread to the proposed cross section. When the constructed thickness is less than 90% of the thickness shown on the plans, aggregate shall be added to obtain the required thickness.
- C. The aggregate shall be compacted to 95% standard proctor density.

END OF SECTION 321217

## **SECTION 321313 CONCRETE PAVING**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. This Section includes exterior Portland cement concrete (PCC) pavement and appurtenances for the following:
  - 1. Driveways and Roadways
  - 2. Parking lots
  - 3. Curbs and Gutters.
  - 4. Sidewalks
  - 5. Site Lighting, Bollard and misc. foundations

#### **1.2 SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Design Mixtures: For each concrete pavement mixture.
- C. Pavement Jointing Plan

#### **1.3 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products who complies with ASTM C 94/C 94M requirements for production facilities and equipment.
- B. ACI Publications: Comply with ACI 301, "Specification for Structural Concrete," unless modified by requirements in the Contract Documents.

#### **1.4 REFERENCES**

- A. *Standard Specifications for Highway Construction*, 2022, Missouri Department of Transportation (MoDOT) herein noted as the Standard Specifications.

### **PART 2 - PRODUCTS**

#### **2.1 STEEL REINFORCEMENT**

- A. Plain-Steel Welded Wire Reinforcement: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.
- B. Deformed-Steel Welded Wire Reinforcement: ASTM A 497, flat sheet.

- C. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed, epoxy coated.
- D. Plain Steel Wire: ASTM A 82, as drawn.
- E. Deformed-Steel Wire: ASTM A 496.
- F. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice."

## 2.2 CONCRETE MATERIALS

- A. Comply with the following as minimums:
  - 1. Portland cement: ASTM C150, Type I.
  - 2. Aggregate: ASTM C33, uniformly graded and clean.
  - 3. Aggregate, coarse: Crushed rock or washed gravel. (Max. Size 3/4" to 1 1/2", w/ 0 - 12% passing #4)
  - 4. Aggregate, fine: Natural washed sand. (Max. Size 3/8" with 3 - 30% passing #50)
  - 5. Water: Clean and potable.
  - 6. Admixtures: Air entraining and/or water reducing agents of standard brand as approved.
  - 7. Fly Ash: ASTM C618, Class C or F.
- B. At least six test cylinders shall be made from trial batches of the design proposed. Two of these shall be broken at 7 days, two at 14 days, and two at 28 days. In lieu of test cylinders the Contractor may furnish a certificate from the concrete supplier that the proposed mix design has been satisfactorily used on other work and that it will meet the requirements of the specifications.
- C. Classes of concrete:
  - 1. Concrete shall be Class B-1 in accordance with the standard specifications.
- D. Consistency shall be such that the mixture can be worked into all parts of the forms and around the reinforcing steel of the structure, without segregation of the materials or the appearance of free water on the surface of the concrete. Unless otherwise stated, the slump measured in accordance with ASTM C143 shall be within the following limits.
  - 1. Floors, walks, and slabs 2" to 4"
  - 2. Forms 9" wide or over 2" to 4"
  - 3. Forms less than 9" wide 3" to 5"
- E. All concrete be air entrained, containing between 4% and 7% entrained air, after mixing is complete and just prior to placement.
- F. Pumped concrete shall comply with ACI 304 and these specifications.

## 2.3 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth.
- B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.



- C. Water: Potable.
- D. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.
- E. Clear Waterborne Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.
- F. White Waterborne Membrane-Forming Curing Compound: ASTM C 309, Type 2, Class B.

## 2.4 CONCRETE PROTECTION

- A. All concrete pavements, sidewalk and curb and gutters shall be treated with a penetrating permanent concrete protection treatment at its time of placement. The treatment shall be a clear penetrating siloxane or silane based sealer for use as shown on exterior concrete. Provide and install in accordance with Section 1059.30 of the Standard Specifications.

## 2.5 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.
- B. Pavement-Marking Paint: Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952, with drying time of less than 45 minutes. The Architect/Engineer shall approve the paint manufacturer.
  - 1. Color: Blue for Accessibility Parking stripes and hatching. White for all other stripes, symbols, words, and hatching.

## 2.6 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Furnish batch certificates for each batch discharged and used in the Work.

# PART 3 - EXECUTION

## 3.1 SUBGRADE PREPARATION

- A. Subgrade preparation shall be in accordance with Section 31 23 00 Excavation and Fill of these specifications.
- B. Geotextile Fabric, Geogrid and Aggregate Base shall be in accordance with Section 32 11 23 Aggregate Base Courses of these specifications.

## 3.2 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for pavement to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

- B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

### 3.3 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
- B. Epoxy coated bars will not be required.

### 3.4 JOINTS

- A. General: Joints in sidewalks and driveways shall be by tooling while the concrete is plastic. Sawed joint may be allowed in pavements and curbs. All sidewalks, driveways and pavements shall be edged. Deformed steel tie bars in Longitudinal Construction Joints shall be placed by drilling and epoxy setting when adjacent slabs are to be constructed separately. Form construction, isolation, and contraction joints and tool edgings true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline, unless otherwise indicated.
- B. Construction Joints: Set construction joints at side and end terminations of pavement and at locations where pavement operations are stopped for more than one-half hour unless pavement terminates at isolation joints.
- C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.
- D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Sawed contraction joints for a depth equal to at least one-fourth of the concrete thickness. Sidewalk joints shall be tooled and not sawed.
- E. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces. Tool joints on all sidewalks and in locations indicated on the Drawings.
- F. Contractor shall submit a jointing plan for approval by owner's representative prior to placing any concrete pavement.

### 3.5 CONCRETE PLACEMENT AND FINISHING

- A. Moisten subbase to provide a uniform dampened condition at time concrete is placed.
- B. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.
- C. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
- D. Strike Off, Consolidation and Finishing: The pavement may be placed utilizing an approved vibrating screed or other approved strike-off and consolidating machine that provides a surface that is uniform texture, true to grade and cross section and free from porous areas. Additional

consolidation with handheld or machine vibrators in front of strike off may be necessary if adequate consolidation is not being achieved. Longitudinal hand bull floating with a float having a min. width of 5 ft for non-vehicular slabs and a min. width of 10 ft for vehicular use slabs will be required. Floats or darbies shall be used at all edges as necessary to provide a uniform surface plane.

- E. General: Do not add water to concrete surfaces during finishing operations.
- F. Exterior Finish:
  - 1. Burlap Finish: Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.
  - 2. Medium-to-Fine-Textured Broom Finish: Draw a soft bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.
  - 3. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.
- G. Interior (smooth) Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats, or by hand floating if area is small or inaccessible to power units. Finish floating to a trowel smooth surface.
- H. Apply surface treatments, if any, per manufacturer's recommendations.

### 3.6 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
- B. Comply with ACI 306.1 for cold-weather protection.
- C. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- D. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound or a combination of these methods.

### 3.7 CONCRETE PROTECTION

- A. Apply penetrating permanent concrete protection treatment to all concrete pavements, sidewalk and curb and gutters at its time of concrete placement at rates as required by the manufacturer.

### 3.8 PAVEMENT TOLERANCES

- A. Comply with tolerances of ACI 117 and as follows:
  - 1. Elevation: 1/4 inch.
  - 2. Thickness: Plus 3/8 inch, minus 1/4 inch.
  - 3. Surface: Gap below 10-foot- long, unlevelled straightedge not to exceed 3/16 inch.
  - 4. Joint Spacing: Max 2 times slab thickness (inches) times 24.

5. Contraction Joint Depth: 1/3 slab thickness, no minus.
6. Joint Width: Plus 1/8 inch, no minus.

B. Curb tolerances:

1. Finished curb surfaces including curb top, face and gutter line shall not vary more than a 1/4" from the testing edge of a 10 foot straightedge. Permissible deficiencies in section thickness will be up to a 1/4".

3.9 PAVEMENT MARKING

- A. Allow concrete pavement to cure for 28 days and be dry before starting pavement marking.
- B. Sweep and clean surface to eliminate loose material and dust. Remove any oil or grease.
- C. Apply paint with mechanical equipment to produce pavement markings of dimensions indicated with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 16 mils.
- D. Paint shall not be applied at air temperatures below 40 degrees F.

3.10 WHEEL STOPS

- A. Securely attach wheel stops into pavement with not less than two galvanized steel dowels embedded in holes drilled or cast into wheel stops at one-quarter to one-third points. Firmly bond each dowel to wheel stop and to pavement. Securely install dowels into pavement and bond to wheel stop. Recess head of dowel beneath top of wheel stop.

3.11 SEALANT

- A. The top 1/4 inch of all sidewalk expansion joints (excluding tooled joints) shall be sealed with a self-leveling polyurethane horizontal sealant complying with ASTM C920, Type M, Grade P, Class 25.
- B. Pavement joints shall be sealed with hot-poured joint sealer in compliance with Article 420.12 and Article 1050.02.
  1. The hot poured sealer shall be placed utilizing a "V" shaped wand tip, to allow penetration of the materials into the joints while providing neat completely filled joints.
  2. Joints shall be completely filled or over banded not to exceed 1 1/2". Excessive over banding shall be removed as directed by the A/E.

3.12 FIELD QUALITY CONTROL

- A. The Owner will provide testing services of a soils engineer and/or independent laboratory for this project.
- B. Upon completion of each test and/or inspection, promptly distribute copies of test or inspection reports to A/E.

C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain one composite sample for the first 10 cu. yd. placed each day, plus one set for each additional 50 cu. yd. placed.
2. Slump: Required 2"-4" - ASTM C 143/C 143M; one test at point of placement for each composite sample of each concrete mixture. Perform additional tests when concrete consistency appears to change.
3. Air Content: Required 6% (-2%, +1%) - ASTM C 231, pressure method, for normal-weight concrete; ASTM C 173/C 173M, volumetric method, for structural lightweight concrete; one test for each composite sample of each concrete mixture.
4. Concrete Temperature: ASTM C 1064/C 1064M; one test per truck when air temperature is 35 deg F and below and when 85 deg F and above.
5. Unit Weight: ASTM C 567, fresh unit weight of structural lightweight concrete; one test for each composite sample of each concrete mixture.
6. Compression Test Specimens: ASTM C 31/C 31M.
  - a. Cast and laboratory cure one set of four (4) standard 6" x 12" or 4" x 8" cylinder specimens for each composite sample.
  - b. Cast and field cure one additional standard cylinder specimen for each composite sample for cold or hot weather concrete.
7. Compressive-Strength Tests: ASTM C 39/C 39M;
  - a. If 6" x 12" cylinders are taken: test one of four laboratory-cured specimens at 7 days and one set of two specimens at 28 days. The forth specimen will be a hold to serve as a spare if specimens do not reach their design strengths.
  - b. If 4" x 8" cylinders are taken: test one of five laboratory-cured specimens at 7 days and one set of three specimens at 28 days. The fifth specimen will be a hold to serve as a spare if specimens do not reach their design strengths.
  - c. A compressive-strength test shall be the average compressive strength from a set of two or three specimens obtained from same composite sample and tested at age indicated.

3.13 REPAIRS AND PROTECTION

- D. Remove and replace concrete pavement that is broken, damaged, or defective or that does not comply with requirements in this Section.
- E. Protect concrete from damage. Exclude traffic from pavement for at least 14 days after placement.
- F. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 321313

## SECTION 329219 SEEDING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Prepare all disturbed earthen areas, fertilizer, seed, and mulch as specified herein, and needed for a complete and proper installation.
- B. Maintenance of newly seeded lawns for warranty period.

#### 1.2 SUBMITTALS

- A. Manufacturer's or vendor's certified analysis for soil amendments and fertilizer materials.
- B. Certification of seed mixture.
- C. Maintenance Instructions: Provide typewritten instructions to the Owner recommending procedures to be established for maintenance of landscape work for one (1) full year. Submit prior to expiration of required maintenance period(s).

#### 1.3 SCHEDULING

- A. Planting seasons shall be as follows:
  - 1. Seeding shall be performed, preferably in the fall from September 1 to October 15. Spring seeding may occur March 1 to April 30.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Packaged Materials: Deliver packaged materials in containers showing weight, analysis, and name of manufacturer. Protect materials from deterioration during delivery and while stored at the project site.

#### 1.5 WARRANTY

- A. Newly seeded lawns shall be warranted through the lawn maintenance period and until final acceptance.

#### 1.6 QUALITY ASSURANCE

- A. General: Ship landscape materials with certificates of inspection required by governing authorities. Comply with regulations applicable to landscape materials.
- B. Analysis: Package standard products with manufacturer have certified analysis.

1.7 JOB CONDITIONS

- A. Utilities: Determine location of underground utilities and perform work in a manner, which will avoid possible damage. Hand excavate as required.
- B. Excavation: When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage conditions, or obstructions, notify the Architect/Engineer before planting.

1.8 RELATED WORK

- A. Section 312300 – Excavation and Fill.

1.9 REFERENCES

- A. ANSI Z60.1-1996 American Standard For Nursery Stock.

**PART 2 - PRODUCTS**

2.1 TOPSOIL

- A. Topsoil shall be placed prior to seeding operations.

2.2 SOIL AMENDMENTS

- A. Lime: Natural dolomitic limestone containing not less than 85% of total carbonates with a minimum of 30 percent magnesium carbonates, ground so that not less than 90 percent passes a 10-mesh sieve and not less than 50 percent passes a 100-mesh sieve.

2.3 FERTILIZER

- A. Commercial Fertilizer: Provide a slow-release starter fertilizer with an analysis of 10-15-30 at a rate of 270 lbs./acre.

2.4 MULCH

- A. Mulch may be applied utilizing one of two methods:
- B. Vegetative mulch:
  - 1. Provide vegetative mulch for seeded areas of a high-quality, air-dried straw of wheat, rye, oats, beans, or other approved straw, free from grass, broom sedge, noxious weeds, and weed seeds detrimental to growth of grass.
  - 2. Mulch shall be applied at a rate of 2 ton per acre and stabilized by crimped in using a dull bladed in line disk with sufficient weight to crimp the straw approximately 2" into the soil.
- C. Hydraulic mulch:

1. Provide virgin wood cellulose fibers complying with the following properties (percent by weight):

- a. Moisture content: 15.
- b. Organic matter, minimum: 95.
- c. Water holding capacity: 400.
- d. pH: 4.3-8.5.

## 2.5 GRASS SEED

- A. General: Provide grass seed, which is:

1. Free from primary noxious weed seeds, and re-cleaned.
2. Certified test results from each lot of seed.

- B. Mixture:

1. Provide the following mixture:

75% Fine Leaf Turf Type Fescue  
10% Perennial Ryegrass  
5% Redtop  
10% Creeping Red Fescue

- C. Seed and fertilizer applications may be modified to suit weather and soil condition at the time of seeding.
- D. Seeding Rate: The seeding rate shall be 6-8 lbs./1000 sq. ft. for new lawns and 3-4 lbs. /1000 sq. ft. for overseeding existing lawn areas.

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. All proposed earthen areas and earthen areas disturbed during construction shall be re-vegetated.

### 3.2 PREPARATION

- A. Loosen subgrade of lawn areas to a minimum depth of 4 inches. Remove stones measuring over 1 inch in any dimension. Remove sticks, roots, rubbish, and other extraneous matter. Limit preparation to areas that will be seeded the same day.
- B. Spread topsoil to the minimum rolled and settled depth required meeting Final lines, grades, and elevations shown on the grading plan. Add lime at a rate of one (1) ton per acre and mix thoroughly into upper 4 inches of topsoil.
- C. Where seeding is required for areas that have not been altered or disturbed by excavating or grading operations, prepare soil as follows: Till to a depth of not less than 4 inches, apply any required soil amendments and initial fertilizers, and remove high areas and fill depressions. Till soil to a fine texture, free of lumps, clods, stones, roots, and other deleterious matter.



Existing grass, vegetation, and turf shall be removed and disposed prior to preparation of unchanged areas. Do not mix existing vegetation into soil being prepared for lawns.

- D. Apply specified commercial fertilizer and mix into upper two (2) inches of soil. Application of fertilizer shall precede the seeding operations by no more than two (2) days.
- E. If necessary, moisten the area to be seeded, being careful not to create a muddy soil situation.

### 3.3 FINISH GRADING

- A. Finish grading will be performed in coordination with Section 312300.
- B. Fine grade areas to be seeded to a smooth, even surface with a loose fine texture. Roll, rake, and drag area, removing ridges and depressions, as required to meet final grades on the grading plan.

### 3.4 SEEDING LAWNS

- A. Sow seed using a spreader or seeding machine. Distribute seed evenly over entire area by sowing equal quantity in two (2) directions at right angles.
- B. Rake the seed into the top 1/8" of soil, roll lightly, and water.
- C. Protect slopes 4:1 and steeper after seeding with erosion mat or netting to be approved by the Landscape Architect.
- D. Mulching: All seeded areas shall be mulched. Seeding shall be completed as a separate operation and shall not be added to the hydraulic mulch slurry if used. Mulch shall not be applied when ambient temperature is at or below freezing. To achieve full and even coverage, the hydraulic mulch shall be applied from two opposing directions if used. Mixing and application rates shall be in accordance with manufacturer's recommendations with a minimum application rate of 2500 lb/acre of hydro-mulch.
- E. Water all newly planted lawn areas and keep moist until the new turf is established.

### 3.5 MAINTENANCE

- A. The maintenance period shall begin immediately after planting.
- B. Maintain seeded lawns for not less than 30 days after substantial completion.
- C. If seeded in the fall and not provided 30 days of maintenance, the maintenance period shall continue into the following spring.
- D. Maintain lawns by watering, fertilizing, weeding, mowing, trimming, and other operations as required to provide a smooth, acceptable lawn for final project acceptance.

### 3.6 CLEANUP AND PROTECTION

- A. Clean pavement and other site areas containing debris resulting from the seeding operations.

- B. Protect existing site elements from damage due to seeding operations. Protect seeded areas from damage by operations of other contractors and trespassers. Maintain protection during installation and the maintenance period. Treat, repair, and/or replace damaged areas.

### 3.7 INSPECTION AND ACCEPTANCE

- A. Upon completion of lawn work. The Owner and Landscape Architect will make a final inspection for final project acceptance.
- B. If lawn work does not comply with requirements, replace rejected work and continue maintenance until accepted.

END OF SECTION 329219

## **SECTION 329300 LANDSCAPING**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

**A. Section Includes:**

1. Edging.
2. Mulch.

#### **1.2 SUBMITTALS**

- A. Product Data:** For each type of product indicated.
- B. Samples of mulch.**
- C. Product certificates.**

#### **1.3 DEFINITIONS**

- A. Backfill:** The earth used to replace or the act of replacing earth in an excavation.
- B. Finish Grade:** Elevation of finished surface of planting soil.
- C. Manufactured Topsoil:** Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
- D. Planting Soil:** Native or imported topsoil, manufactured topsoil, or surface soil modified to become topsoil; mixed with soil amendments.
- E. Subgrade:** Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill, before placing planting soil.
- F. Subsoil:** All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

#### **1.4 QUALITY ASSURANCE**

- A. Installer's Field Supervision:** Require Installer to maintain an experienced full-time supervisor on Project site when planting is in progress.

#### **1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver materials to site and confirm new undamaged condition.**

## **PART 2 - PRODUCTS**

### **2.1 MULCHES**

#### **A. Mineral Mulch: Trap Rock**

1. Size Range: 3/4 inch maximum, 1/2 inch minimum.
2. Color: To be selected by Owner from manufacturer standard samples and colors.

### **2.2 WEED-CONTROL BARRIERS**

#### **A. Polyethylene Sheeting: ASTM D 4397, black, 0.006-inch minimum thickness.**

#### **B. Nonwoven Fabric: Polypropylene or polyester fabric, 4 oz./sq. yd. minimum. Typar. Dewitt or approved equal spunbonded polypropylene weed barrier having a tensile strength of 135 lbs. and a permeability of 70 gallons per square yard.**

### **2.3 EDGING**

#### **A. Precast concrete edgers, nominal 12" long, 3.5" wide and 3.5" height.**

#### **B. Pavestone "Edgestone" or approved equal.**

## **PART 3 - EXECUTION**

### **3.1 PLANTING BED ESTABLISHMENT**

#### **A. Loosen subgrade of planting beds to a minimum depth of 6 inches. Remove stones larger than 1/2 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.**

1. Apply superphosphate fertilizer directly to subgrade before loosening.
2. Thoroughly blend planting soil mix off-site before spreading; or spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil mix.
3. Spread planting soil mix to a depth of 6 inches but not less than required to meet finish grades after natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.

#### **B. Finish Grading: Grade planting beds to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.**

### **3.2 MULCHING**

#### **A. Install weed-control barriers before mulching according to manufacturer's written instructions. Completely cover area to be mulched, overlapping edges a minimum of 6 inches. Tape or pin seams as recommended by manufacturer.**

- B. Mulch backfilled surfaces of planting beds and other areas indicated. Provide mulch ring around trees in lawn areas.
  - 1. Organic Mulch and Mineral Mulch: Apply 3-inch average thickness of mulch, and finish level with adjacent finish grades. Do not place mulch against plant stems.

END OF SECTION 329300

## **SECTION 331110**

### **SITE WATER DISTRIBUTION**

#### **PART 1 - GENERAL**

##### **1.1 SUMMARY**

- A. Section includes pipe and fittings for site water line including domestic water line, fire water line and valves, fire hydrants.
- B. Related Sections:
  - 1. Section 312316 - Excavation and Fill.
  - 2. Section 312333 – Trenching and Backfilling.

##### **1.2 SUBMITTALS**

- A. Product Data: Provide data on pipe materials, pipe fittings, valves and accessories.
- B. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

##### **1.3 REFERENCES**

- A. ASTM D698 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, Using 5.5 lb Rammer and 12 inch Drop.
- B. ASTM D2922 - Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
- C. ASTM D3017 - Test Methods for Moisture Content of Soil and Soil-Aggregate Mixtures.
- D. ASTM D3139 - Joints for Plastic Pressure Pipes using Flexible Elastomeric Seals.
- E. AWWA C502 (American Water Works Association) - Dry Barrel Fire Hydrants.
- F. AWWA C509 (American Water Works Association) - Resilient Seated Gate Valves 3 in through 12 in NPS, for Water and Sewage Systems.
- G. AWWA C900 (American Water Works Association) - Standard for Polyvinyl Chloride (PVC) Pressure Pipe, 4 inch through 12 inch, for Water.

##### **1.4 CLOSEOUT SUBMITTALS**

- A. Project Record Documents: Record actual locations of piping mains, valves, connections, thrust restraints, and invert elevations.
- B. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

- C. Operation and Maintenance Data: Section 017700 - Contract Closeout.

## 1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with manufacturer's standards.
- B. Valves: Manufacturer's name and pressure rating marked on valve body.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store valves in shipping containers with labeling in place.

# PART 2 - PRODUCTS

## 2.1 WATER PIPE

- A. Manufacturers:
  - 1. Johns-Manville Blue Brute PVC Class water pipe.
  - 2. Substitutions: Section 01600 - Product Requirements.
- B. PVC Pipe: AWWA C900 Class 150 DR-18:
  - 1. Fittings: AWWA C111, cast iron. Cor-blue steel bolts.
  - 2. Joints: ASTM D3139 compression gasket ring.
  - 3. Trace Wire: Magnetic detectable conductor, clear plastic covering, imprinted with "Water Service" in large letters.
- C. Push-on-Joint, Ductile-Iron Pipe: AWWA C 151, with push-on-joint, bell-and plain-spigot end, unless flanged ends are indicated. Class 150.
  - 1. Push-on-Joint, Ductile-Iron Fittings: AWWA C 110, ductile- or gray-iron, standard pattern; or AWWA C 153, ductile-iron, compact pattern.
    - a. Gaskets: AWWA C 111, rubber.
- D. Service Pipe: 2 inches or smaller:
  - 1. Type K Copper.

## 2.2 GATE VALVES - 3 INCHES AND OVER

- A. Manufacturers:
  - 1. Mueller.
  - 2. American Flow Control.

- B. AWWA C509, Iron body, bronze trim, non-rising stem with square nut, single wedge, resilient seat, mechanical joint ends, control rod, extension box, epoxy coated interior.
- C. R.W. Type. Open left.

## 2.3 HYDRANT

- A. Manufacturers:
  - 1. Clow Model Medallion.
  - 2. Mueller Model Centurion 200.
  - 3. American Model B-84-B.
  - 4. Substitutions: Section 01600 - Product Requirements.
- B. Hydrant: AWWA C502, UL 246, dry barrel type, inside dimension of 7 inches minimum, with minimum 5 inches diameter valve seat opening; minimum net water area of barrel not less than 190 percent of valve opening; 6 inch flanged type inlet connection with accessories, gland bolts, and gaskets.
- C. Hydrant Extensions: Fabricate in multiples of 6 inches with rod and coupling to increase barrel length.
- D. Hose and Streamer Connection: Match sizes and type of thread with City of Hallsville requirements, two 2-1/2" hose nozzles, and one 4-1/2" pumper nozzle.
- E. Finish: Primer and two coats of enamel in color required by utility company and fire department. Barrels shall be painted green. The cover, cap and chain shall be painted white.
- F. Traffic model type. Open right.

## 2.4 BEDDING AND COVER MATERIALS

- A. Bedding: Fill Type A1 as specified in Section 310516.
- B. Cover: Fill Type A1, as specified in Section 310516.

## 2.5 ACCESSORIES

- A. Concrete for Thrust Restraints: Concrete type specified in Section 030000.
- B. Service Boxes: Tyler 95E, with lid marked water.
- C. Mainline valve boxes: two piece, screw type Tyler Series 6850, with 5-1/4" drop lid marked water.
- D. Mainline Couplings: Smith-Blain 442 cast coupling or equal.
- E. Corporation and curb stops: Ball valve type. Corporations have CC tapered threads. Ford or Mueller. Corporation stops - Ford F600 or equal. Curb stops - Ford B21 or B22 or equal.
- F. Swivel quarter or eight bends: Ford L02 or LA02 or equal.



- G. Trace wire: Magnetic detectable conductor, clear plastic covering, imprinted with "Water Service" in large letters.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Section 011115 - Administrative Provisions: Coordination and project conditions.
- B. Verify that building service connection and municipal utility water main size, location, and invert are as indicated.

#### **3.2 PREPARATION**

- A. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, remove burrs.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare pipe connections to equipment with flanges or unions.

#### **3.3 BEDDING**

- A. Excavate pipe trench in accordance with Section 312333 for Work of this Section.
- B. Form and place concrete for pipe thrust restraints at any change of pipe direction. Place concrete to permit full access to pipe and pipe accessories. Provide 9 sq ft thrust restraint bearing on subsoil.
- C. Place bedding material at trench bottom, level fill materials in one continuous layer not exceeding 6 inches compacted depth; compact to 95 percent.
- D. Backfill around sides and to top of pipe with cover fill, tamp in place and compact to 95 percent.
- E. Maintain optimum moisture content of fill material to attain required compaction density.

#### **3.4 INSTALLATION - PIPE**

- A. Maintain separation of water main from sewer piping in accordance with Missouri DNR requirements.
- B. Group piping with other site piping work whenever practical.
- C. Route pipe in straight line.
- D. Install pipe to allow for expansion and contraction without stressing pipe or joints.
- E. Slope water pipe and position drains at low points.
- F. Form and place concrete for thrust restraints at each elbow or change of direction of pipe main.

- G. Establish elevations of buried piping to ensure not less than 5 ft of cover.
- H. Install trace wire continuous over top of pipe. Buried 6 inches below finish grade, above pipe line; coordinate with Section 312333. Bring tracer wire into valve boxes and coil at the top or bring to a junction box attached to a fire hydrant at the surface.
- I. Backfill trench in accordance with Section 312333.

### 3.5 INSTALLATION - VALVES AND HYDRANTS

- A. Set valves on solid bearing.
- B. Center and plumb valve box over valve. Set box cover flush with finished grade.
- C. Set hydrants plumb; locate pumper nozzle perpendicular to and facing roadway.
- D. Set hydrants to grade, with nozzles at least 20 inches above ground.
- E. Locate control valve 4 inches away from hydrant.
- F. Provide a drainage pit 36 inches square by 24 inches deep filled with 1/2 inch washed gravel. Encase elbow of hydrant in gravel to 6 inches above drain opening. Do not connect drain opening to sewer.
- G. Section 014500 - Quality Control: Testing and inspection services.
- H. Compaction testing will be performed in accordance with ASTM D698, ASTM D2922, ASTM D3017.
- I. If tests indicate Work does not meet specified requirements, remove Work, replace, and retest.

END OF SECTION 331110

## SECTION 334100 STORM UTILITY DRAINAGE PIPING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Provide storm sewerage system were shown on the Drawings, and as specified herein.
- B. Related work:
  - 1. Documents affecting work of this Section include, but are not necessarily limited to, General Conditions, Supplementary Conditions, and Sections in Division 1 of these Specifications.

#### 1.2 SUBMITTALS

- A. Comply with pertinent provisions of Section 013219.
- B. Product data: If requested by the Engineer/Architect (A/E), within 15 calendar days after the Contractor has received the Owner's Notice to Proceed, submit:
  - 1. Materials list of items proposed to be provided under this Section.
  - 2. Manufacturer's specifications and other data needed to prove compliance with the specified requirements.

#### 1.3 REFERENCES

- A. *A. Standard Specifications for Missouri Department of Transportation, 2022*, herein noted as the Standard Specifications.

### PART 2 - PRODUCTS

#### 2.1 PIPE MATERIALS FOR SEWERS

- A. Sewer pipe shall comply with Sections 1026 & 1027 of the Standard Specifications for the type, class, and size of pipe as shown on the Plans and as described herein:
- B. In addition to the list of materials in Sections 1026 & 1027 the following materials shall be used when specified:
- C. Reinforced Concrete Pipe (RCP):
  - 1. Comply with ASTM C 76.
  - 2. Minimum Class III and as specified in Section 1042 of the Standard Specifications.
  - 3. Use tongue and groove joints wrapped with engineering fabric, unless a rubber O-ring or profile gasket complying with ASTM C 443 is specified.

D. Polyvinyl Chloride Pipe (PVC):

1. Solid wall PVC Pipe complying with ASTM D 3034 or ASTM F 679.
2. PVC plastic meeting ASTM D 1784, Cell Classification 12454.
3. SDR 26: Minimum pipe stiffness of 115 psi (pipe 4" to 15" diameter).
4. Pipe stiffness per ASTM D 2412, 46 psi (pipe 18" to 27" diameter).

E. High Density Polyethylene Pipe (HDPE):

1. AASHTO M 294, Type S corrugated exterior and smooth interior.
2. ASTM D 3350 minimum resin Cell Classification 335420 C.
3. Minimum pipe stiffness at 5% deflection according to ASTM D 2412.
4. Integral bell and spigot joints with elastomeric seals complying with ASTM F 477.
5. Maximum 5% deflection of the average inside diameter by testing after installation.

F. Corrugated Metal Pipe (CMP):

1. AASHTO M 36, Type I.
2. Zinc coating complying with AASHTO M 218.
3. Corrugated steel circular section with annular or helical corrugations.
4. Gage of pipe according to MoDOT Standard Specification Section 725.1.3 or as specified in the contract documents.
5. Coupling bands with annular or helical corrugations to match pipe ends.

G. Pipe Drains, Underdrains and French Drains materials shall comply with Section 605 of the Standard Specifications for the type, class, and size of pipe as shown on the Plans and as described herein.

H. Manholes, Inlets, and Drainage Structure materials shall comply with applicable Section 604, 726, 731, 732 & 733 of the Standard Specifications for the type of structure, frame and grate or lid as shown on the Plans and as described herein.

### PART 3 - EXECUTION

#### 3.1 PREPARATION & LAYOUT

- A. Before starting excavation, establish location and extent of underground utilities occurring in the work area. Utilities shown on the plans indicate the best knowledge of the Owner with regard to general location and nature of the facilities in the area. They are shown for the convenience of the Contractor and shall not relieve the Contractor of the responsibility to properly investigate and protect the utilities. The Contractor shall remain responsible for damages to existing utilities whether indicated on the plans or not.
- B. The Contractor shall notify the Missouri One Call System (1-800-DIG-RITE) and the Owner or his/her site representative 48 hours prior to start of work.
- C. Field Conditions: Verify location and elevation of existing facilities where connections are to be made.

### 3.2 INSTALLATION

- A. Storm sewer pipe and structures shall be installed in accordance with applicable Sections 604, 605, 726, 731, 732 & 733 of the Standard Specifications.
- B. Excavation and backfilling for sewers, manholes, structures and appurtenances, shall comply with governing Federal State laws and municipal Ordinances as may be necessary to protect life, property, or the work. In any event, the minimum protection shall conform to the rules and regulations of the Occupational Safety and Health Act (OSHA) Standards for Construction.
- C. Line and Grade
  - 1. Reference points and bench marks for controlling lines and grades are shown on the Drawings. All additional horizontal and vertical measurements that will be required to complete the work, in addition to the controlling lines and grades, shall be the responsibility of the Contractor.
- D. Backfilling Trenches
  - 1. Backfill above the center line of the pipe shall be in accordance with Section 726 of the Standard Specifications, as shown on the Drawings.
  - 2. Aggregate trench backfill shall be placed beneath and within 2 ft. of areas of proposed pavements, walks, footings, foundations, slabs or other structures.
  - 3. Jetting or watersoaking to obtain compaction will not be allowed.
  - 4. Compaction of the backfill shall be based on Standard Proctor Density (ASTM D698) methods and shall meet the following requirements:

| a. | Area/Condition                | Percent of Std Proctor |
|----|-------------------------------|------------------------|
|    | Footings, Foundations         | 95%                    |
|    | Pavements, walks, floor slabs | 95%                    |

END OF SECTION 334100

## **SECTION 334101 SANITARY SEWERAGE SYSTEM**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. Provide sanitary sewerage system including construction and installation of piping, manholes, and structures as specified herein, and conforming in all respects to the lines and grades shown on the Drawings, together with all specified or necessary accessories and appurtenances.
- B. Related work:
  - 1. Documents affecting work of this Section include, but are not necessarily limited to, General Conditions, Supplementary Conditions, and Sections in Division 1 of these Specifications.

#### **1.2 SUBMITTALS**

- A. Product data: Within 15 calendar days after the Contractor has received the Owner's Notice to Proceed, submit:
  - 1. Materials list of items proposed to be provided under this Section.
  - 2. Manufacturer's specifications and other data needed to prove compliance with the specified requirements.

#### **1.3 QUALITY ASSURANCE**

- A. Use adequate numbers of skilled workers who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

#### **1.4 PRODUCT HANDLING**

- A. Comply with pertinent provisions of Section 016600.

#### **1.5 PERMITS AND ENTRY UPON LANDS**

- A. The Owner will obtain permits and/or easements for entering upon private lands, public streets, roads and highways, railroads, etc. to the limits and lines shown on the Plans for construction purposes. The Contractor shall confine his operations to the outlined areas and shall comply with all special instructions shown on the Plans or set forth in the Contract Documents.

#### **1.6 UTILITIES**

- A. Existing underground utilities are herein defined as consumer service connections, such as water, gas, sewer, electric, telephone, etc., and also culverts, sanitary sewers, storm sewers,

combined sewers, water mains, underground power lines, gas mains and the usual appurtenances thereto.

1. No attempt is made to indicate or show accurate location of all underground utilities in the line of, or crossing the proposed work. In general, wherever record information was available of locations and wherever field location was possible during surveys, the approximate position of utilities is shown on the Plans. These are primarily for the purpose of indicating the approximate position of the underground lines with respect to the proposed sewer lines.
2. The determination of the exact location of all existing facilities, and all other pipes, services and structures, and their proper protection, support and maintenance during all construction operations; it is the expressed responsibility of the Contractor in the performance of this contract. Contractors are advised to secure any additional information, relative to the underground utility lines, by consulting with proper private and public officials, under whose jurisdiction the maintenance and operation of the utility lines lie, and/or by field investigations at his own expense.
3. Wherever underground utilities are disturbed or damaged as a result of the construction work proposed herein and such utilities can be replaced at their original locations and grades, all costs in connection with such replacement work shall be borne by the Contractor and no separate or extra payment will be made therefore.
4. Where existing underground utilities are in actual contact with the new work, so that such utilities cannot be replaced as originally found prior to excavation, and where relocation and changes are required, then the work shall be replaced or relocated by "others" at no cost to the Contractor. The Contractor shall so coordinate his work as to allow a reasonable time for such replacement or relocation and in no event shall extra compensation be allowed for such coordination or any reasonable delay occasioned therefrom. Should it be found necessary or desirable by the Owner for the Contractor to perform the work of replacement or relocation, the Engineer/Architect will issue in writing a field order defining the extent of the additional work and instructing the Contractor to proceed with such construction. Compensation for such work shall be determined as set forth in the General Specifications, under "Extra, Additional, or Omitted Work - Payment."

#### 1.7 TREES, SHRUBBERY, STRUCTURES AND ABOVE GROUND UTILITIES

- A. All trees, shrubbery, utility poles and the like in the line of work shall be protected and preserved except as shown on the Plans, unless permission of the Owner and approval of the Engineer/Architect are obtained for their removal. Construction operations may require hand trenching and tunneling under and adjacent to trees and poles, which are to be preserved.
  1. Private and/or public walls, steps, walks, drives, roads, roadbeds, fences or other structures except trees in the line of work shall be replaced to as good a condition as prior to the start of excavation.
  2. All grassed surface areas shall be replaced to a condition equal to that found prior to the start of work.
  3. Erosion control measures shall be in accordance with Standard Specifications for Soil Erosion and Sediment Control as contained in IEPA/WPC/87-012 or current edition.
  4. Existing structures and markers such as inlet castings, fire hydrants, highway and street signs, valve boxes, etc., that may be disturbed during the progress of the work, shall be cleaned and reset in their original position in such a manner as may be required by the Engineer/Architect.

## **PART 2 - PRODUCTS**

### **2.1 SEWER PIPE**

- A. Vitrified Clay Pipe (ESVCP) conforming to ASTM C 700 (Extra Strength).
- B. Concrete Pipe, Reinforced (RCCP) conforming to ASTM C 76, Classes I, II, III, IV, or V.
- C. Ductile Iron Pipe (DIP) conforming to ANSI A-21.5I (AWWA C-15I) Thickness designed per ANSI A 21.50 (AWWA C-150) tar (seal) coated and/or cement lined per ANSI A-21.4 (AWWA C-104).
- D. Polyvinyl Chloride (PVC) Pipe conforming to ASTM D 1784 "Rigid Poly (Vinyl Chloride) and Chlorinated Poly (Vinyl Chloride) Compounds" and ASTM D 2241 latest revisions. Minimum acceptable SDR shall be 26. Include the appropriate ASTM Designations and Cell Classification Numbers (12454-B or 12454-C) or other approved classifications).

### **2.2 JOINTS**

- A. Extra Strength Vitrified Clay Pipe joints shall conform to ASTM C 425. Plain end VCP shall be with PVC bell material conforming to ASTM C 1784 and flexible gasket meeting ASTM C-425 specifications.
- B. Concrete Pipe joints shall be confined O-ring Type conform to the latest ASTM C 361.
- C. Ductile Iron Pipe shall have push-on or mechanical joints complying with the latest revision of ANSI/AWWA Specification C111/ A-21.II.
- D. PVC Pipe joints shall use flexible elastomeric seals per ASTM D 3212.

### **2.3 CONCRETE**

- A. All concrete for manhole bottoms, special structures, and incidental items shall be as specified in Section 033000.

### **2.4 CASING PIPE**

- A. Steel casing pipe of the diameter and thickness specified in the plans for Cathodically Protected Pipe or Non-Cathodically Protected pipe. Minimum yield strength of 35,000 psi.

### **2.5 SEAL PLUGS**

- A. Seal plugs for all service lateral openings shall be air tight, as manufactured by Fernco Joint Sealer Co., Ferndale, Mich., or approved equal.



## 2.6 MANHOLE

- A. Manholes shall be precast reinforced concrete manhole sections and bases with rubber gasket joints complying with latest revisions of ASTM C 478. Diameter shall be 48" for sewer pipes 15" and smaller, and 60" for sewer pipes up to 36".
- B. Manhole steps shall be copolymer polypropylene plastic with steel reinforcement, (PS2-PF), or equal, and meet or exceed ASTM specifications D 2146 under Type 2 Grade 49108.
- C. Opening for sewer pipe connections shall be resilient connectors meeting the latest revisions of ASTM C923.
- D. Manholes shall be provided with cast iron frame and closed lids, (Neenah R-1015) or equal when located within the roadbed or buried conditions. Use a Neenah R-1077-B Frame and Type B lid or equal at other locations. All manhole lids shall be furnished with small pick holes.

## 2.7 BEDDING OR GRANULAR CRADLE

- A. Bedding or Granular cradle material shall comply with ASTM D2321, Class II, consisting of coarse sands and gravels with a maximum particle size of 20 mm (3/4in.), including various graded sands and gravels containing small percentages of fines, generally granular and non-cohesive.

## 2.8 SELECT GRANULAR BACKFILL

- A. Select Granular Backfill materials shall consist of sand, crushed stone, pit run or crushed gravel well graded within the following limits.

# PART 3 - EXECUTION

## 3.1 SURFACE CONDITIONS

- A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the work. Do not proceed until unsatisfactory conditions are corrected.
- B. Field Measurements - Make necessary measurements in the field to assure precise fit of items in accordance with the approved design.

## 3.2 INSTALLATION - TRENCH EXCAVATION

- A. All excavation work for sewers, manholes, sewer structure and sewer appurtenances, as herein defined, includes the clearing of the site of the work, the loosening, loading, removal, transporting and disposing of all excavated materials, wet or dry, necessary to be removed and replaced (backfilling) for purposes of sewer construction. All excavation shall be unclassified unless otherwise specifically specified. The ground shall, in general, be excavated in open trenches unless otherwise shown on the Drawings to be bored and jacked and/or in tunnel.

- B. Trenches shall be excavated to the depth required for the bedding and foundations of the sewers and appurtenances shown on the Drawings and profiles; and, where conditions make it necessary, to such additional depths as may be directed in writing by the Engineer/Architect.
- C. Should the trench be excavated without written authority to a depth greater than that required by the said Drawings and profiles, the Contractor shall refill such excess excavation at his own expense, with crushed stone which shall be tamped until solid, with 2000 psi concrete, or as otherwise directed by the Engineer/Architect.
- D. Where a firm foundation is not encountered at the grade established, due to soft, spongy, or other unsuitable soil, unless other special construction methods are called for on the Drawings, all such unsuitable soil under the pipe and for the width of the trench shall be removed and replaced with well compacted bedding material, as may be directed in writing by the Engineer/Architect.
- E. Whenever excavation is made for installing sewer pipe across private property, the top soil disturbed by excavation operations shall be replaced as nearly as possible in its original position, and the whole area involved in the construction operations shall be left in a neat and presentable condition.
- F. The width of the trench at the top of the sewer pipes shall be as shown on the Drawings at Trench Detail. However, a greater width may be permitted by the Engineer/Architect, in writing, when it is necessary for the proper construction of the sewer according to the plan.
- G. In general, trenches shall be only of sufficient width to provide a free working space on each side of the sewer pipe according to the size of the pipe and the character of the ground as shown on the Drawings; but in every case there shall be sufficient space between the pipe and the side of the trench, not less than six (6) inches, to make it possible to thoroughly ram the bedding around the pipe and to secure proper tight joints.
- H. All surplus excavated material, debris and rubbish shall be removed from the site by the Contractor.
- I. When the Contractor constructs the trench with sloped sides or benched, backfilling for the full width of the excavation shall be as hereinbefore specified, except no additional compensation will be allowed for trench backfill material required outside the limits of the specified trench width.
- J. In general, the Contractor shall furnish suitable spoil areas, but the Engineer/Architect reserves the right to designate certain spoil areas, provided the haul distance shall not exceed one (1) mile.
- K. The Contractor must take full responsibility and the risk of meeting quicksand, hardpan, boulder clay, rubbish, unforeseen obstacles, underground conduits, railroad tracks, pavements, etc. No claim for any amount of money, beyond the contract price of the work, will be entertained or allowed on account of the character of the ground in which the trench or other excavations are made, except for removal of unsuitable sewer pipe foundation material as authorized by the Engineer/Architect.

### 3.3 LINE AND GRADE

- A. Reference points and bench marks for controlling lines and grades will be established by the Engineer/Architect. Such work shall consist of referenced locations of all points of intersection, or changes in direction or grade. Controlling grades shall consist of Bench Marks along the line

800 feet apart. All additional horizontal and vertical measurements that will be required to complete the work, in addition to the controlling lines and grades, shall be made by the Contractor and at his sole responsibility. No compensation shall be paid the Contractor for the cost of any of the work or for delay occasioned by giving lines and grades or for inspection; but such cost shall be included in the prices specified for the appropriate items.

### 3.4 ROCK EXCAVATION AND BLASTING

- A. Wherever rock is encountered in the trench excavation, it shall be removed to a depth of six (6") inches below the sewer pipe as shown in detail on the Drawings.
- B. Extreme care shall be used wherever blasting is necessary for the removal of rock, large boulders, or other hard material. The Contractor shall conform his acts to and shall obey all rules and regulations for the protection of life and property that may be imposed by any public authorities or that may be made from time to time by the Engineer/Architect relative to the storing and handling of explosives and the loading and firing of blasts. Signals of danger shall be given before the firing of any blast and blasts shall not be fired until all persons in the vicinity are known to have reached positions out of danger there from.
- C. In case injury occurs to any portion of the work, or to the materials surrounding or supporting the same, through blasting, the Contractor, at his own expense, shall remove such injured work and shall rebuild the same and shall replace the material surrounding or supporting the same, or shall furnish such material and perform such work or repairs or replacements as the Engineer/Architect may order. Any damage whatever to any existing structure due to blasting shall be promptly, completely, and satisfactorily repaired by the Contractor at his own expense.

### 3.5 SHEETING AND BRACING

- A. The Contractor shall furnish, install and maintain such sheeting, bracing, etc., as may be required to support the sides of the excavation and to prevent any movement which can in any way injure the sewers, diminish the necessary width of the excavation, or otherwise injure or delay the work or endanger adjacent pavements, buildings or other structures. Sheeting and bracing shall be provided in accordance with Missouri DNR Standards.
- B. For sheeting and bracing which is specifically shown upon the drawings, or ordered in writing by the Engineer/Architect, to be left in place, the Contractor shall receive payment, in accordance with the General Conditions.

### 3.6 PROTECTION AGAINST WATER

- A. The Contractor shall do all pumping and bailing, build all subdrains and drains, and do all other work necessary to keep the trench and sewer clear of groundwater, sewage, or storm water during the progress of the work. Where the excavation for its depth is in whole or in part in wet sand, or where conditions warrant it, in the judgment of the Engineer/Architect, the Contractor shall install a pumping system connected with well points so as to drain the water from the water-bearing strata effectively.
- B. When existing sewers and laterals have to be taken up or removed, the Contractor shall provide and maintain temporary outlets and connections for all private or public drains, sewers, or catch basins, and he (she) shall take care of all sewage and storm water which will be received from these drains and sewers and discharge the same; and for this purpose he (she) shall provide

and maintain at his own expense an efficient pumping plant and temporary outlets; and be prepared at all times to dispose of the water and sewage received from these temporary connections, until such time as the permanent connections shall be made by the Contractor in a careful and workmanlike manner.

### 3.7 PIPE LAYING OPERATIONS (EXCEPT PVC)

#### A. General:

1. Sewer pipe shall, under all conditions, be laid in a dry-trench on an even, firm bed throughout the full length of the barrel so that no uneven strain will come on any pipe. The intent of the specifications is to maintain a dry trench and to properly bed the sewer pipe as shown on the Drawings. Pipe laying operations shall be carried on in a manner, which will insure against subsequent misalignment laterally and vertically; and to eliminate subsequent groundwater infiltration. The trench shall be kept continuously dry at all times, and the pipe bedded full length of the barrel so that a firm, even bearing will result for the bottom quadrant of the pipe as shown on the Drawings. Bell holes for bell and pipe shall be carefully made and be no larger than required to properly free the bell from bearing on the subgrade and to properly make up the pipe joints.
  - a. Protect pipe during handling against shocks and free fall. Remove extraneous material from the pipe interior.
  - b. Lay pipe by proceeding upgrade with the spigot ends of bell-and-spigot pipe pointing in direction of flow.
  - c. Lay each pipe accurately to the indicated line and grade, aligning so that the sewer has a uniform invert.
  - d. Before making pipe joints, clean and dry all surfaces of the pipe to be joined.
  - e. Use lubricants, primers, and adhesives recommended for the purpose by the pipe manufacturer.
  - f. Place, fit, join, and adjust the joints to obtain the degree of water tightness required.

#### B. Foundations and Bedding:

1. All sewer pipe shall be laid on a crushed stone bedding Type "A" or Type "C" granular cradle, having a minimum thickness of 6 inches below the pipe and extending around and up to the pipe as shown on the Drawings.
2. In trenches where a dry, firm subgrade cannot be maintained due to groundwater seepage into the trench, the subgrade shall be excavated to a depth of six inches below sewer pipe and shall be backfilled with crushed stone to form subdrain pipe bedding to the shape and dimensions as detailed on the Drawings. This will not be a pay item unless ordered by the Engineer/Architect to be placed at a depth greater than six inches below bottom of pipe.
3. When solid rock is encountered, the trench excavation shall conform to the shape and dimensions shown on the detailed Drawings and shall be backfilled with crushed stone or sand to form the pipe bedding.

#### C. Sewer Joints:

1. In general all sewer pipes shall be jointed in accordance with the recommendations and instructions of the pipe manufacturer.
2. At manholes a compression type polyurethane joint complying with ASTM Specification C-425 shall be used to join each influent and effluent line to the manhole as manufactured by Moorbace or equal. The sewer pipe shall be securely and completely

encased in a metallic grout mortar through the opening in the wall. The metallic grout mortar shall be Embeco Grout Mortar by Master Builders; or equal.

3. Wherever dissimilar types of pipe are to be joined together outside of a manhole or other structure, the pipe shall be joined with suitable adapters, such as Fernco Couplings as manufactured by the Fernco Joint Sealer Co., Ferndale, Michigan 48220, or equal.

D. Existing Drains, Sewers, and Laterals:

1. Any existing drain or sewer not in conflict with the new work, which is disturbed or removed on account of the new work under this contract, whether shown on the Drawings or not, shall be restored or reconnected. Existing drains and sewers encountered in the work which are not in conflict with new work are, in general, to be restored by and at the expense of the Contractor, excepting that extensions thereof ordered by the Engineer/Architect and new portions of such old drains or sewers authorized by the Engineer/Architect, will be paid for at the contract prices for sewer of the same size, or as extra work. Connection to be made to the new sewer shall be made through tees, or wyes in the main.
2. Existing laterals, sewers or drains shall be restored with pipe of the same size and equal or better in type and quality. They shall be firmly supported across the trench by timbering, blocking, masonry, or other suitable manner to prevent after-settlement.
3. No existing sewers or drains shall be connected to the new sewer except as specifically shown on the Drawings or approved by the Engineer/Architect.

3.8 PVC PIPE INSTALLATION AND FIELD TESTING

A. Installation:

1. Pipe shall be installed in full compliance with the Recommended Practice for "Underground Installation of Flexible Thermoplastic Sewer Pipe," ASTM Standard D 2321. In addition to the construction and testing procedures outlined in other sections of the specifications, the Contractor shall be required to install the pipe in such a manner so that the diametric deflection of the pipe shall not exceed 5% and the materials surrounding the pipe shall be compacted to the required Standard Proctor Densities outlined in D 2321. The area requiring compaction shall include the bed and sidefill material and also the material placed above the pipe for a distance of 6 inches over the top of the pipe. The Engineer/Architect may require up to 10 random compaction tests to be completed by an independent laboratory. If any of these tests indicate that the material has not been compacted to the required density, the Contractor shall recompact said material at no additional cost to the Owner, and the Engineer/Architect shall then have the right to require additional compaction tests to insure that this or other material is compacted to the proper density without any additional cost to the Owner.

B. Pipe Handling:

1. Care shall be taken during the transporting of the pipe to ensure that the binding and tie down methods do not damage or deflect the pipe in any manner. Pipe bent, deflected or otherwise damaged during shipping shall be rejected.
2. Pipe stored on the job site shall be covered with canvas or other opaque material to protect it from the sun's rays. Air circulation shall be provided under the covering.
3. PVC pipe shall not be removed from the pallet and/or laid out along the ditch until the bedding material is in place and ready to receive pipe. Only enough pipe should be laid out for one days' work.

C. Laying Pipe:

1. Lateral displacement of the pipe shall be prevented during embedment operations. Pipe shall not be laid in water, or under unsuitable weather or trench conditions.
2. Pipe laying shall begin at the lowest elevation, with bell ends facing the direction of laying except when reverse laying is permitted by the Engineer/Architect. Pipe jointing and installation shall be specifically in accordance with the manufacturer's recommendations except as otherwise specified herein, for the type used.

D. Backfill:

1. Backfill shall be placed in accordance with paragraph 3.9 below.

3.9 BACKFILLING TRENCHES

A. General:

1. After sewers are laid and bedded in open cut, the trench shall be backfilled to the original ground surface. Unless otherwise ordered, the backfilling shall not be left unfinished for more than three hundred (300) feet behind the completed pipe work.
2. As soon as the pipe is tested, the entire width of the trench shall be backfilled with material, as shown on the Trench Detail, and for the Case as shown in the plan and profile.

B. Backfill:

1. Case I:
  - a. In this case backfill, from the center line of the pipe to the surface shall be made by any acceptable method, which will not dislodge or damage the pipe or cause bridging action in the trench. Only selected excavation material, free from clods or stones, shall be used in backfilling up to 6" above the top of the pipe.
  - b. All trench backfill shall be compacted by jetting and watersoaking in the manner described below. The trench compaction shall be started at the point of lowest elevation of the trench and work up along the trench. Jetting and watersoaking shall not begin until the trench has been backfilled to within six (6) inches of the finished surface.
  - c. The holes through which water is injected into the backfill shall be centered over the trench backfill and at longitudinal intervals of not more than six (6) feet. Additional holes shall be provided if deemed necessary by the Engineer/Architect to secure adequate settlement. All holes shall be jetted and shall be carried to a point one (1) foot above the top of the pipe. Drilling the holes by means of augers or other mechanical means will not be permitted. Care shall be taken in jetting so to prevent contact with, or other disturbance of the pipe.
  - d. The water shall be injected at a pressure and rate just sufficient to sink the holes at a moderate rate. After a hole has been jetted to the required depth, the water shall continue to be injected until it begins to overflow the surface. The Contractor shall, at his own expense, bore test holes at such locations as the Engineer/Architect may designate in order to determine the effectiveness of the water soaking. An approved soil auger shall be used for boring test holes. As soon as the jetting and watersoaking has been completed, all holes shall be filled with soil and compacted. Surface depressions resulting from backfill subsidence caused by jetting and watersoaking shall be filled and recompact by tamping or rolling to the satisfaction of the Engineer/Architect. The location where Case I is required shall be indicated on the Drawings.

2. Case IV:

- a. This case applies to those areas where, in the opinion of the Engineer/Architect, due to the nature of the soil or other factors, the use of jetting or water-soaking for compaction of the trench will not give satisfactory results. In this case, backfill material above the granular cradle to a point twelve (12) inches above the top of the pipe shall be placed in layers of six (6) inches thickness, loose measure, and each layer firmly compacted by ramming or tamping with tools approved by the Engineer/Architect in such manner as not to disturb or injure the pipe. The balance of the backfill material shall be placed in uniform layers of twelve (12) inches thickness, loose measure, and each layer shall be compacted by ramming or tamping with tools approved by the Engineer/Architect. All compaction under this case shall be not less than 80% optimum, modified proctor, for the soil. The location where Case IV is required shall be indicated on the Drawings.

3. Case V:

- a. This case applies to those areas where watermain, pipe sewers, or other conduits are crossing open areas where early settlement is not critical. In this case, backfill, from the center line of the pipe to the surface, shall be made by any acceptable method, which will not dislodge or damage the pipe or cause bridging action in the trench. Only selected excavated material free from clods or stones shall be used in backfilling up to six (6) inches above the top of the pipe. Water-soaking or other methods of trench settlement will not be required in this case. Excess material shall be neatly rounded over the top of the trench as directed by the Engineer/Architect to allow for settlement of the trench. In final clean-up operations, the Contractor shall reshape the surface to level out any uneven settlement that has occurred. The location where Case V is required shall be indicated on the Drawings.

3.10 MANHOLE CONSTRUCTION

A. General:

1. Manholes shall be constructed at the locations, to the depths, and of the materials, shown on the Drawings. Backfill shall be as shown on the Drawings and shall be compacted as specified for the sewer pipe backfill.
2. Concrete bottoms shall be carefully shaped to channelize and direct the sewage flow, as shown on the manhole detail on the Drawings.
3. All unused holes in the precast concrete rings shall be closed with concrete plugs and sewer joint compound.
4. Where the flow line grade of an incoming sewer is more than two feet above the flow line grade of the manhole, a drop connection shall be provided as shown on the Drawings.
5. Standard manholes shall be constructed and backfilled within 48 hours after sewer pipe is laid and drop manholes within 96 hours after sewer pipe is laid at the manhole location.

3.11 TEMPORARY SEWER CONNECTIONS

- A. Where special junction chambers or structures are to be constructed or where existing sewers carrying sanitary sewage and storm water are encountered, the Contractor shall provide and maintain temporary connections to prevent public nuisances and to prevent pollution. The costs of all such temporary connections, pumping and diversions shall be considered incidental to the

scope of work. No separate payment will be made for such or similar items of work. No such existing sewers shall be connected to the new sewers unless shown on the Drawings or approved by the Engineer/Architect and/or the Owner.

### 3.12 SEWER PIPE AND WATER MAIN SEPARATION

A. Sanitary sewers, house sewers or storm drains that are laid in the vicinity of pipe lines designated to carry potable water shall meet the following conditions.

1. Parallel Installation – Sewers and Water Mains:

- a. Normal Conditions - Any sanitary sewer, storm sewer or sewer manhole shall be located at least 10 feet horizontally from water mains, whenever possible; the distance shall be measured from edge to edge.
- b. Unusual Conditions - When local conditions prevent a horizontal separation of 10 feet, a storm or sanitary sewer may be laid closer to a water main provided that:
  - 1) The bottom of the water main is at least 18 inches above the top of the sewer.
  - 2) Where this vertical separation cannot be obtained, the sewer shall be constructed of materials and with joints that are equivalent to water main standards of construction for 10 feet measured perpendicular on either side of the water main.

2. Crossings – Sewers and Water Mains:

- a. Normal Conditions - Water mains crossing house sewers, storm sewers or sanitary sewers crossing water mains shall be laid to provide a separation of at least 18 inches between the bottom of the water main and the top of the sewer.
- b. Unusual Conditions - When local conditions prevent a vertical separation as described above, the following construction shall be used:
  - 1) Sewers passing over or under water mains should be constructed of the materials equivalent to Watermain Standards.
  - 2) Construction of sewers crossing over water mains shall insure additional protection to the water main by providing:
    - a) A vertical separation of at least 18 inches between the bottom of the sewer and the top of the water main;
    - b) Adequate structural support for the sewers to prevent excessive deflection of joints and settling on and breaking the water mains;
    - c) That the length of watermain type sewer pipe be centered at the point of crossing so that the joints will be equidistant and as far as possible from the water main.

### 3.13 CLEANING, INSPECTION AND TESTING

A. Cleaning and Maintenance:

- 1. Special care shall be taken during the construction of the sewers to prevent rubbish of every kind and description, and especially sand, from entering or remaining in the sewers. As the construction of the system approaches completion, the Contractor shall systematically and thoroughly clean and make any needed repairs to the entire length of



the sewers. He (she) shall furnish, at his own expense, suitable tools and labor for cleaning out all dirt and foreign substances from the sewers, and, if necessary, water for cleaning the sewers by flushing. The cleaning and the repairs above described shall be arranged as far as practicable to be completed upon the finishing of the whole construction work. The Owner will make, upon the completion of the cleaning operations, final inspection of the work.

B. Inspection:

1. The sewer shall be subject to inspection at such times as the Engineer/Architect may direct. All repairs necessary by the inspection shall be made. Broken or cracked pipe shall be replaced; defective joints, if any, replaced; all deposits removed; and the sewer left true to line and grade, entirely clean, free from lumps of protruding jointing material, etc., and ready for use. Each section of sewer between manholes shall show, upon examination from either end a reasonably full circle of light.

C. Testing:

1. Air Testing – General:

- a. The proposed sanitary and force mains will be tested for acceptability by the air testing technique. Special attention of the Contractor is directed to the requirement that all pipe laying will be permitted only in dry trenches having a stable bottom, inasmuch as it is imperative that all sewers and manholes be built practically or reasonably watertight and airtight. The Contractor must adhere rigidly to the specifications for materials and workmanship covering sewer construction. After completion, the sewers or sections thereof shall be tested with a low-pressure air test, which is a test to determine the rate at which air under pressure escaped from an isolated section of sewer. The rate of air loss is intended to indicate the presence or absence of pipe damage and whether or not the joints have been properly constructed. This test is not intended to indicate water leakage limits. In applying the low-pressure air test to sanitary sewers several factors should be understood and precautions followed during the test.
- b. Plugs should be securely braced to prevent the unintentional release of a plug, which can become a high velocity projectile. Plugs should not be removed until all air pressure in the test section has been released.
- c. For safety reasons, no one should be allowed in the trench or manhole while the test is being conducted.
- d. The testing apparatus should be equipped with a pressure relief device to prevent the possibility of loading the test section with the full compressor capacity.
- e. The pipe should be tested in a wet condition if at all possible.

2. Low Pressure Air Test:

- a. Provide necessary labor and equipment to test the proposed sewer extension by means of a low-pressure air test. Test each section manhole to manhole to determine its tightness. Should a section not pass the air test as set forth in the above specification, the Contractor will locate the defect and repair the leak. The ultimate responsibility for ensuring that the proposed sewer does perform according to the specification will be with the Contractor.

3. Air Testing – Procedure:

- a. The section of the sewer to be tested shall be backfilled and cleared, and plugged at each end by means of inflatable stoppers, securely braced to prevent possible

blow-out due to the internal air pressure. The pneumatic plugs shall have a sealing length equal to or greater than the diameter of the pipe to be tested and then shall be inflated to 25 psig. Air is then added to the test section until the internal air pressure is raised to 4 psig above the average back pressure of ground water over the sewer pipe, and the air pressure shall be allowed to stabilize for at least 10 minutes and a maximum of 30 minutes.

- b. After the stabilization period, the pipe in the test section shall be pressurized to 3.5 psig and the time in minutes measured for the pressure to drop to 2.5 psig. If ground water is present, the air pressure in the line shall be increased to 3.5 psig above the level of the ground water and the drop of one pound of air pressure measured in minutes. The section being tested should be deemed acceptable when the time taken for the one (1) pound pressure drop is not less than that allowable per Missouri DNR standards.

4. Time Limits for Loss of Air Pressure:

- a. The loss of air is acceptable and the line is considered to be reasonably free from defects, if the time in minutes and seconds for the pressure to go from 3.5 psig to 2.5 psig is not less than the time per inch of pipe diameter per length of sewer pipe as shown in the table above.

3.14 PVC PLASTIC PIPE TESTING

A. Air Testing:

1. The PVC sewer main shall be tested for acceptability by the air testing technique as specified above in Cleaning, Inspection and Testing.

B. Deflection Testing for Flexible Conduit:

1. The project engineer/architect shall randomly select portions of the project to be deflection tested. Such portions shall consist of the manhole intervals in the initial 1200 feet of sewer and not less than 10% of the remainder of the sewer project.
2. If the deflection test is to be run using a rigid ball or mandrel, it shall have a diameter equal to 95% of the base diameter of the pipe as established in proposed ASTM D-3034. The test shall be performed without mechanical pulling devices.
3. The individual lines to be tested shall be so tested no sooner than 30 days after they have been installed.
4. Wherever possible and practical, the testing shall initiate at the downstream lines and proceed towards the upstream lines.
5. No pipe shall exceed a deflection of 5%.
6. In the event that the deflection exceeds the 5% limit in 10% or more of the manhole intervals tested, the total sewer project shall be tested.
7. Where deflection is found to be in excess of 5% of the original pipe diameter, the contractor shall excavate to the point of excess deflection and carefully compact around the point where excess deflection was found. The line shall then be retested for deflection. However, if after the initial testing the deflected pipe fail to return to the original size (inside diameter) the line shall be replaced.

C. Final Cleaning:

1. Upon completion of all testing, the Contractor shall clean the PVC sewer in such a manner as to ensure that no foreign matter or debris has been left in the sewer. All

foreign matter and debris shall be removed and disposed of in a manner acceptable to the Engineer/Architect.

### 3.15 RESTORATION OF SURFACE AREAS

#### A. General:

1. After backfilling operations are completed, surface areas shall be replaced or restored as called for on the Drawings, which in general shall be to a condition equal to that existing prior to start of work. In areas with Case V backfill, the top of the trench shall be completed as shown on the Trench Detail, or reshaped once by machine with the backfill being left slightly mounded, not over 12 inches, above natural ground surface. Restoration shall not be done sooner than thirty (30) days after the backfill is placed.
2. All pavements and sidewalks shall be replaced to a condition equal to that previously existing and as shown in typical detail on the Drawings
3. At streets, street intersections, driveway entrances, and at any other pavement location disturbed during construction, the Contractor shall place crushed stone surfacing to maintain traffic.
4. In general the Contractor shall confine his damage of improved surfaces to a minimum, and any unnecessary damage shall be replaced by him (her) at his entire cost and expense. The Engineer/Architect shall determine what damage is unnecessary and his judgment shall be final.

#### B. Seeding:

1. The grass surface area disturbed during construction shall be seeded for the complete width of disturbed area in accordance with the applicable articles of the Missouri Department of Transportation, "Standard Specifications for Highway Construction."
2. The Contractor shall maintain the seeded area, watering, reseeding, patching, etc., as necessary, until a satisfactory acceptable stand of grass is obtained. Damage resulting from erosions, gullies, washouts, shall be repaired by filling with top soil, tamping, and reseeding, by the Contractor at his expense, if such damage occurs prior to final acceptance.
3. Seed mixture shall be in accordance with Section 329100.

### 3.16 MARKER TAPE

- A. An electrically detectable metalized foil marking tape shall be installed with the sewer main and laterals to facilitate locating the sewer with an electronic pipe finder. The marker tape shall consist of a 5.5 mil composition film containing one layer of metalized foil laminated between two layers of inert plastic film formulated for prolonged underground use, and shall be resistant to alkalis, acids and other destructive agents found in the soil. The tape shall be safety green in color, 3" wide, and shall bear a continuous message printed in permanent ink warning of the underground installation.
- B. Installation shall be continuous along the centerline for the full length of the sewer line and shall be installed at a depth of 2 to 3 feet.
- C. Installation shall be for all service laterals, and sewer mains where the manholes are buried. In lines with buried manholes, run tape from downstream exposed manhole, above sewer line and all buried manholes, to upstream exposed manhole.

- D. The tape shall be "Detectable Terra Tape" as manufactured by Reef Industries, Inc., Houston, Texas, or equal.
- E. No separate payment will be made for marker tape.

### 3.17 BORING AND ENCASEMENT

- A. At locations shown on the Drawings, the sewer pipe shall be ductile iron with steel encasing pipe installed in a bored hole.
- B. Bore holes shall be made in advance of the sewer construction so that, if necessary, minor adjustments can be made in alignment and grade with the approval of the Engineer/Architect. Bore pits shall be backfilled and compacted for settlement. See Drawings for backfill Case.
- C. Casing pipe shall be pushed through the embankment without use of pilot by the Boring-Jacking Method. This method utilizes an auger operating inside the pipe to carry out dirt, but not to cut in advance of the pipe itself.
- D. Where traffic must be maintained, the operations shall be carried on without encroachment upon the traveled way by either the excavation or by the storage of equipment or materials. Adequate sheeting and bracing shall be provided if the nature and condition of the soil or height of exposed faces is such as to endanger either the traveling public or the integrity of the road surfacing. Construction shall be in accordance with required permits for the work.

### 3.18 GUARANTEE

- A. The Contractor shall guarantee all materials and workmanship furnished, and shall replace or repair any damage due to settlement of backfill in trenches or pavement for a period of one (1) year from date of acceptance.

END OF SECTION 334101